

HAZARDOUS WASTE MANAGEMENT
PRACTICES OF THE ONTARIO
DRY CLEANING INDUSTRY

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HAZARDOUS WASTE MANAGEMENT PRACTICES
IN THE ONTARIO DRY CLEANING INDUSTRY

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Beak Consultants Limited

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1.0 SUMMARY

As part of its mandate to identify and regulate the shipment and disposal of hazardous wastes, the Waste Management Branch of the Ministry of the Environment may prepare a policy document on the dry cleaning industry in Ontario.

This report was prepared to inventory and characterize the wastes generated by Ontario dry cleaners. Information was obtained by an industry survey in which 308 dry cleaners provided data relating to annual purchases of cleaning solvent, types and quantities of waste generated, and disposal methods practiced. In addition, sixteen dry cleaning plants were sampled to determine and characterize the solvent content in their waste residues. On the basis of these results, extrapolations were made to determine waste quantities and solvent volumes disposed of by the total dry cleaning industry in Ontario.

It is estimated that there are about 1,300 dry cleaners in operation in Ontario. Over 90% of these establishments use perchloroethylene as the cleaning solvent, with the balance using petroleum solvent (about 10%) or fluorocarbons (0.2%).

Cartridge filters and distillation units are used in approximately 90% of the perchloroethylene plants to condition and clean used solvent. These processes generate wastes in the form of spent cartridge filters and still bottom sludges from the distilling process.

Almost all (99% by weight) of the still bottom sludges containing perchloroethylene are accumulated on-site and then sent to recyclers for reclaim of the solvent. Most of the sludges from petroleum solvent plants (97%) are hauled to industrial landfill sites for disposal. The quantity of solvent losses via still bottom sludges was estimated to be 181,900 kg/yr from perchloroethylene plants and 39,500 kg/yr from petroleum solvent plants.

Most cartridges from perchloroethylene plants are disposed to municipal refuse. These cartridges are estimated to contain about 77,800 kg of perchloroethylene for the Ontario dry cleaning industry. Petroleum solvent losses in cartridges were estimated to be 22,200 kg/yr. Most of the cartridges from petroleum solvent plants are hauled to an industrial landfill site.

Most perchloroethylene plants using cartridge filters practice some form of recovery of the solvent from the cartridges. Cabinet/sniffer technology is the most commonly used. Steam-stripping is used in less than 20% of the facilities. It appears that about 1% perchloroethylene in spent filter cartridges is the lowest concentration achievable by any of the methods currently used in Ontario to remove solvent from the cartridges.

The conditioning of solvent by diatomaceous earth filtration is practiced in only about 11% of all dry cleaning plants in Ontario. The residue generated by this process, termed cooked filter muck, is disposed to secure landfill sites by the majority of plants using perchloroethylene or petroleum solvent. Approximately 13,000 kg/yr and 16,400 kg/yr of solvent losses occur via these wastes from perchloroethylene and petroleum solvent plants, respectively.

The total quantity of perchloroethylene disposed of in solid or liquid waste residues from dry cleaning plants in Ontario totalled approximately 294,900 kg in 1986, or 7.3% of the total volume of solvent purchased annually. The majority of solvent losses (almost 82%) appear to be air emissions.

Waste residues from petroleum solvent plants contained 78,100 kg of solvent, equalling 6.3% of the total solvent purchases in 1986 for the dry cleaning industry in Ontario. The majority of petroleum solvent losses are also likely to be through air emissions.

2.0 INTRODUCTION AND SCOPE

2.1 Introduction

Recent changes in Regulation 309, Ontario's waste management regulation, have resulted in more detailed definitions of hazardous wastes. As part of its mandate to identify and control the shipment and disposal of hazardous wastes under this regulation, the Waste Management Branch of the Ministry of the Environment may prepare a policy document on the dry cleaning industry in Ontario.

Dry cleaning operations represent a significant source of waste material, including still bottom sludges from the distillation of perchloroethylene which have been defined as a hazardous waste. Other wastes generated by dry cleaning establishments which also contain perchloroethylene include spent filter cartridges and diatomaceous earth filter muck from solvent filtration equipment.

As no quantitative estimates of volumes have been developed for the Ontario industry, the Ministry of the Environment requested an industry survey to identify the number of dry cleaning establishments in Ontario, quantities of wastes generated by these plants, as well as methods and type of equipment used to handle these wastes. BEAK Consultants Limited developed this background document for the MOE on the dry cleaning industry in Ontario identifying the geographic distribution of the industry, the type of processing technology used, types and quantities of wastes that could be considered hazardous, and existing regulations in other jurisdictions.

2.2 Scope

The ultimate objective of this report was to provide a comprehensive background document for the Ministry of the Environment to use in policy development for potential regulation of wastes generated by the dry cleaning industry in Ontario.

To that end, the scope of this report involved:

- survey of the industry in Ontario as to geographic distribution;

- survey of the industry to determine the cleaning process technology distribution;
- survey of the industry to determine the types and quantities of wastes generated;
- survey of the industry to determine in-plant solvent recovery technologies available;
- contact with other jurisdictions in the United States and Canada to determine the status of regulations pertaining to the dry cleaning industry;
- evaluation of the industry's response to changes in technology for cleaning or solvent recovery; and
- identification, discussion and recommendation of feasible options for the management of generated wastes in Ontario.

2.3 Study Methodology

2.3.1 Database Development

A listing of all the dry cleaning establishments in Ontario by name, address and telephone number was initially required to establish a database to determine the total number of dry cleaners in the province. A subsequent breakdown of dry cleaning plants by MOE region, processing technology and solvent use was developed through a questionnaire survey.

Southam Direct Mailing Services (SDMS) provided BEAK with a "yellow pages" listing of 1,924 establishments under the classification of "cleaners" in the province of Ontario. This list was compiled from a number of sources including yellow and white page telephone directories and select Southam-published trade journals. However, this list of "cleaners" included not only dry cleaners, but other services such as conventional launderers, carpet cleaners, janitorial services, tailors, general stores and shoe repair stores. These obvious non-dry cleaners were totalled to represent 175 listings, which were eliminated from the original starting list supplied by SDMS.

The revised list of dry cleaners was then divided into MOE regions, with same name companies grouped together. In many cases, multiple listings under the same name represented only one plant directly involved in the actual dry cleaning process, while the other listings were simply depots for clothing drop-off. Consequently, a total of 433 plants were eliminated on the assumption that their operation was strictly as a depot.

Table 2.1 gives a summary of the database development. From the starting list of 1,924 establishments, 175 listings were removed as being other "cleaning" services, while 433 listings were eliminated on the basis of depot operation only, giving a final estimated number of 1,316 dry cleaning establishments in the province of Ontario. Appendix 1 gives the establishment listing.

TABLE 2.1

SUMMARY OF DATABASE DEVELOPMENT

STARTING LIST		1,924
Exclude Obvious Non-Dry Cleaners		
Laundries	60	
Alterations/Tailors	39	
General Store	35	
Maintenance/Janitorial	19	
Carpet Cleaners	17	
Shoe Repair	<u>5</u>	
	175	175
Exclude Known or Assumed Depots		433
Estimated Total Number of Ontario Dry Cleaners		1,316

The Dry Cleaners and Launderers Institute (DCLI) estimated that approximately half of all dry cleaning plants in Ontario are members of the association. DCLI members total approximately 550 to 600, giving an estimate of approximately 1,200 dry cleaning establishments for both non and DCLI members. As this figure is close to that determined by BEAK, the estimate of 1,316 dry cleaners in Ontario appears reasonable.

2.3.2 Questionnaire

A mail-out questionnaire survey, developed in conjunction with the DCLI, was conducted to obtain relevant information from a relatively random sample of dry cleaners selected from the establishment listing. The information extracted from these questionnaires was included in the database for manipulation in terms of plant size distribution, geographic distribution, type of processing technology, type of solvent, quantity of solvent used, reclaim and recycle practices, and disposition of wastes. A sample questionnaire form is given in Appendix 2. The questionnaire was sent with a confidentiality statement without which it was felt the response would be slim.

A total of 308 questionnaires were sent out to dry cleaning establishments, with the number of questionnaires sent to each MOE region proportional to the total number of cleaners in that region. However, since the northwestern region had only a few listings (a detailed breakdown by region is discussed later in Section 4.2), a greater proportion of questionnaires were sent to this region than to the other five in order to ensure an adequate number of responses.

A representative sample of dry cleaners by size was also desired to develop an adequate database. The establishment listing in Appendix 1, however, only provides the name, address and telephone number of the dry cleaner, with no indication of size, solvent use, or processing technology. Therefore, it was assumed that major operators could be identified by plants with 4 or more outlets, medium-sized operators by 2-3 listings, and small plants by only one listing. As there were only 36 listings for plants with 4 or more outlets, all of these were mailed a questionnaire. The large plants were double-checked with the DCLI list to ensure none were omitted. The remainder of the questionnaires were sent to medium and small plants divided by proportion to each region.

Upon return of the questionnaire, each was reviewed thoroughly to ensure complete and reasonable responses. In some cases, the answers did not seem logical, so a telephone follow-up to these plants was made to confirm and/or correct the questionable answers.

2.3.3 Site Visits and Sampling

Sampling of wastes from dry cleaning plants was conducted to obtain information on solvent content in still bottom sludges, filter muck and spent filter cartridges. Plants were chosen to represent all possible combinations of plant size, solvent type and processing technology, as discussed further in Section 5.1 and Section 5.2. Resampling was done at one selected plant to allow for an estimation of in-plant variability. Thus both plant-to-plant variations and in-plant variations were obtained.

Plant selection was also based on convenience of plant location to the BEAK office, with site visits only in the central and west-central regions. A total of 16 plants were sampled with the focus primarily on hot and transfer technology using perchloroethylene, as these represent up to 90% of the industry in Ontario.

2.3.4 Data Evaluation

Data evaluation was performed in two stages. The initial step involved the evaluation of the questionnaires. This data was processed to obtain the distribution of dry cleaning establishments by size (in terms of quantity of clothing processed per month), processing technology, solvent use and quantities and types of wastes generated.

The second stage in the data evaluation involved the extrapolation of results obtained from the questionnaires to province-wide estimates. This information also helped to provide a profile on the dry cleaning industry in Ontario.

The results determined from the sampling of wastes from individual dry cleaners were used in conjunction with the questionnaire results to provide an estimate of solvent losses to the environment via wastes generated. A mass balance was then made to quantify solvent losses to determine the overall fate of solvents used in the dry cleaning industry.

3.0 INDUSTRY PROCESSING TECHNOLOGY

The process of dry cleaning involves the washing of textiles with a non-aqueous solvent. Various solvents are used or have been used for this process. These include petroleum or Stoddard solvent, carbon tetrachloride, trichloroethylene, perchloroethylene (tetrachloroethylene), 1,1,1-trichloroethane and various fluorocarbons.

Perchloroethylene, commonly referred to as "perc", has been the preferred solvent for use in dry cleaning plants for the past three decades due to its stability, high water insolubility, good recoverability and relatively low cost. Prior to that time, Stoddard solvent was the predominant dry cleaning solvent, but its use declined due to the fire hazard presented by its flammability. These petroleum solvents (e.g., trade name Varsol™) still account for roughly 10 to 15% of dry cleaning solvent use in Ontario.

There are three different dry cleaning processes or technologies commonly used in the dry cleaning industry. They are the following:

1. Cold or Transfer Technology;
2. Hot or Dry-to-Dry Technology; and
3. Refrigerated or Fully-Enclosed Technology.

3.1 Cold or Transfer Technology

In transfer technology (also called wet-to-dry processing), fabrics are first washed with solvent in a washer-extractor similar to a conventional front loading washing machine. Fresh solvent is pumped from a storage reservoir usually located beneath the washer. The washing cylinder revolves and tumbles the textiles into the continually recirculating solvent. During the cleaning cycle, the solvent is continuously filtered to remove soil, lint and other particulate material removed from the fabrics. Normal practice is to provide a sufficient solvent flow to create one solvent volume change per minute of wash cycle. After the timed wash cycle, the solvent is drained from the washer and then the fabrics are spun in the cylinder to remove or extract solvent by centrifugal action. The small quantities of water and detergent present as additives in the solvent (used to remove water soluble dirt) are also removed from the fabrics during the spin/extraction cycle.

Following the extraction process, the clothing is manually removed or "transferred" from the washer-extractor to a reclaiming tumbler-dryer. Total transfer time can vary from one to three minutes. During the initial phase of the drying cycle, the clothing is tumbled dry with forced hot air. The solvent-laden air from this initial phase is passed over a water-cooled condensing coil to recover solvent removed from the fabrics. This air is then reheated and directed back into the drying cylinder. This phase of the drying process lasts approximately fifteen to twenty minutes, and is a closed loop process with no external venting of the unit.

The drying cycle concludes with an aeration or deodorization phase with ambient air to remove any final traces of solvent. Dampers are opened on the drying unit either manually or automatically and outside air is drawn in. The unit is simultaneously vented either to the outside of the plant, or to a secondary recovery device which will remove the last traces of solvent in the discharge air. The most commonly used secondary recovery device is a carbon adsorption unit usually referred to as a "sniffer". This system normally consists of 135 to 180 kg of carbon contained within a housing. A fan on the unit draws the vented air from the tumbler through the carbon bed where any traces of perc are adsorbed. The purified air, which usually contains less than 30 ppm of perc, is then vented outside the plant. The carbon in the sniffer is regenerated on a regular basis. In an "average" plant, this stripping process yields 15 to 25 litres of perchloroethylene everytime the unit is stripped. The carbon bed has a life span of 5 to 7 years and does not represent a major source of wastes from drycleaning plants.

In most plants, the washer-extractor unit is equipped with a fan which is automatically activated during the transfer operation to create a negative draft at the door of the unit. The air drawn into the washer-extractor in this operation is also vented to the carbon adsorber.

Recovered solvent condensed out in the initial phase of the drying process passes through a baffled water separator, where the denser solvent settles while the "floating" water is discharged, first to a bucket and then to the municipal sewer system. In some installations, the discharged water is piped directly to the sewers. However, this is not considered advisable since a malfunction in the system could cause solvent to be unknowingly lost into the sewers. Concentrations of perchloroethylene in water discharged to municipal sewers have been found to range from 1 to 40 ppm. The recovered solvent is then returned to the solvent storage tank generally through a closed pipe or in some instances, by manual transfer.

Figure 3.1 gives a simplified schematic representation of a typical transfer process. The mode of operation used may vary from plant to plant depending on modifications implemented by individual operators. However, the basic operation is the same.

Both perchloroethylene and petroleum solvent are used with transfer technology. It is, in fact, the only technology used with petroleum solvents. In the petroleum plants, there are a couple of significant variations to the process previously described. Historically, reclaiming tumblers have not been used in petroleum plants. Although they are now available, most plants still use conventional type tumblers which simply vent outside the plant. A petroleum-reclaiming tumbler is considerably more elaborate and expensive than its perc counterpart. Because of the flammability of Stoddard solvent, these units must be explosion-proof. Also, because of the relatively high boiling point of Stoddard solvent, these units operate under vacuum. Both of the foregoing factors add considerably to the cost of these units.

There are no secondary recovery devices used in petroleum plants as they are generally regarded as not economically competitive.

3.2 Hot or Dry-to-Dry Technology

In "hot", or dry-to-dry units, the washer-extractor and tumbler-reclaimer functions are combined into a single unit. All the operations in this process are similar to those used in transfer technology with the obvious elimination of the transfer step. Due to the elimination of the transfer operation, these units generally make more efficient use of perchloroethylene than cold units, provided they are properly operated and maintained. Since the drying operation is done in the same cylinder as the washing operation, hot units must be of greater capacity than their cold counterparts to achieve the same level of production. Hot units are used only with perchloroethylene. It is significant to note that these units are also vented to a carbon adsorption unit of the type described earlier. Figure 3.2 depicts a typical dry-to-dry operation.

3.3 Refrigerated or Fully-Enclosed Technology

Refrigerated technology is similar to hot technology in that all operations are accomplished in one unit. However, as the name implies, the unit is completely sealed

FIGURE 3.1: Typical Transfer Process

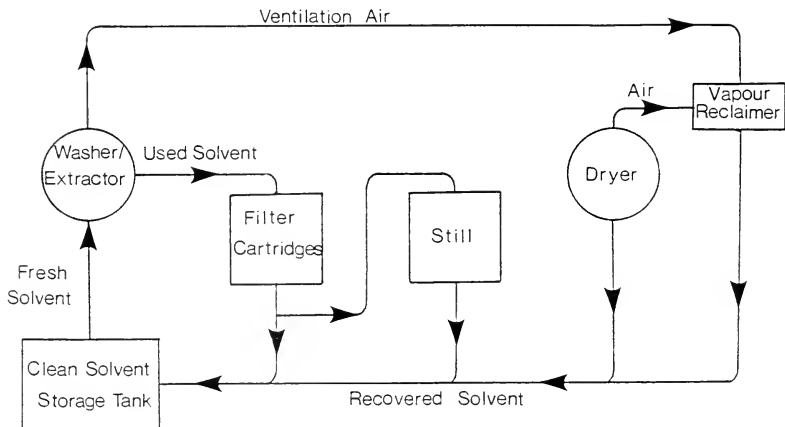
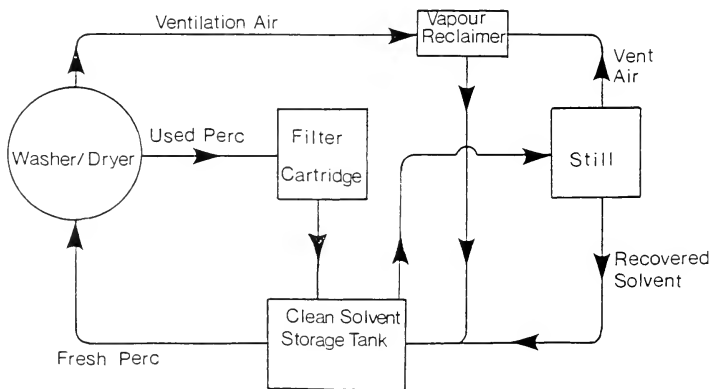


FIGURE 3.2: Typical Hot Process



with no venting to either the atmosphere or a secondary recovery unit. For obvious reasons, this leads to considerably more efficient use of the solvent than in either of the two methods previously described. In order to eliminate the need for venting, these units employ refrigeration units instead of conventional steam/electric heat and water-cooled condensing coils. The refrigeration-evaporating coil acts as the condensing coil for the solvent, while the refrigeration-condensing coil acts as the heating unit. These units generally employ R-502 refrigerant operating under a fairly high pressure. This produces enough heat in the refrigeration condenser to almost eliminate the need for any further source of heat. However, most of the fully-enclosed units are equipped with some sort of steam or electric heat booster. The cold temperature produced by the refrigeration-evaporating coil leads to extremely efficient solvent recovery, thereby eliminating the need for a deodorization cycle and hence the need for venting.

As was the case with hot technology, these refrigerated units must be larger than transfer units to achieve the same level of production. In North America, the majority of refrigerated units use perchloroethylene, although there is some use of trichlorotrifluoroethane (Freon 113). Because of their extreme volatility, these fluorocarbon solvents must be used in fully-enclosed units.

3.4 Solvent Reconditioning and Recovery Systems

3.4.1 Approach to Reconditioning and Recovery

Solvent discharged from the dry cleaning process contains soluble oils, fat and grease, as well as insoluble particulate matter which was removed from the clothing during the wash cycle. These compounds tend to impart odours and other undesirable characteristics to the solvent. For the majority of dry cleaning operations in Ontario, these impurities are removed from the solvent by continuous filtration of the solvent through cartridge filters or diatomaceous earth filters, during the wash cycle. Periodic distillation of the solvent is also required to remove non-volatile residues.

In distillation units, the contaminated solvent is heated to its boiling point, and the vapours are condensed to recover pure solvent. The various non-volatile residues remain behind as still-bottoms. This process is relatively unsophisticated in terms of process control, which leads to large variations in the amount of solvent contained in the still

bottoms.

Many petroleum and even some perchloroethylene plants have either reduced or eliminated the distillation process in recent years. In the case of perchloroethylene plants, this is generally done to eliminate the costs of distillation which can be substantial, particularly if a distillation unit is not functioning properly.

Distillation units for petroleum solvent generally operate under vacuum due to the relatively high boiling point of these solvents. Distillation is often eliminated due to the lack of availability of the vacuum distillation units. As these units wear out, many operators find it more economical to dispose of spent solvent rather than attempt to locate a new vacuum still or rebuild their existing distillation unit.

In dry cleaning plants where distillation has been discontinued, operators will condition the solvent by filtration. Most establishments, however, will use both filtration and distillation.

Filtration of spent solvents is most commonly accomplished using cylindrical cartridges which are categorized based on the type of inner filter matrix:

Paper Cartridge: Consists of heavy paper folded in accordian-type pleats. Standard and Jumbo sizes.

Carbon-Core Cartridge: Consists of an outer ring of pleated paper with an inner core of granular activated carbon. Standard and Jumbo size.

Solid Carbon Cartridge: Contains only granular activated carbon. Used in conjunction with either carbon-core or plain paper cartridges. Standard and Jumbo size.

Adsorptive Cartridge: Small outer ring of pleated paper with large inner core of activated carbon and clay. Jumbo size only.

The filter matrix is enclosed within a perforated metal shell. Solvent flows from the

exterior of the cylinder through the small perforations into the inner annulus. Insoluble particles are removed by the paper portion of the filter. In the case of carbon-core or adsorptive cartridges, the inner core of the carbon and/or clay acts to remove solvent soluble dyes, fatty acids and other undesirable materials. Solid carbon cartridges are used only for the control of fugitive dyes.

The cartridges, which are contained within a filter housing, can be used in several different configurations depending on the manufacturer of the unit. One type of filtration unit may contain as many as twenty-one of these cartridges. Larger establishments may run a number of these units in parallel. Cartridges generally have a service life of 300 to 500 kg of clothing processed. However, depending on the dry cleaner, cartridges may be changed as often as every 200 kg, to as infrequently as 1000 kg of dry cleaning processed.

Soil filtration can also be accomplished using diatomaceous earth filters. Unlike cartridges which are "disposable" units, diatomaceous earth filters contain a permanent mesh which acts as a support for the filtering medium. These filter screens of cloth or metal can be flat; tubular or in bag form, with the tubular arrangement being the most common. Diatomaceous earth is added to the solvent and the solvent is then circulated through the filter. As the diatomaceous earth passes through the filter, it collects on the screens and forms a filtering medium. This medium remains intact as long as constant solvent pressure is maintained. As the filtering medium becomes spent, back pressure increases and solvent flow drops to an unacceptable level. The filter cake is then purged from the unit, generally by compressed air, or occasionally by mechanical force. The filter cake containing diatomaceous earth, various soils and solvent is then distilled or "cooked" to remove and recover the entrapped solvent. The resulting cooked filter muck is generally a fairly dry powder. The use of diatomaceous earth filtration has declined substantially mainly due to the convenience and cleanliness of cartridge filtration. Also, diatomaceous earth is a silica and as such is classed as a Designated Substance under the Ministry of Labour's Occupational Health and Safety Regulation. This act imposes strict regulations on the storage and handling of such substances. It is interesting to note, however, that recent developments in filtration technology in Europe have drastically increased the convenience, efficiency and hence the viability of diatomaceous earth filters. This could lead to the increased use of this type of filtration once again.

3.4.2 Solvent Recovery from Cartridge Filters

There are three basic methods used to remove perchloroethylene from spent cartridge filters. These include:

1. Drying with room temperature air;
2. Drying with hot air; and
3. Azeotroping with live steam.

The recovery of perc from filter cartridges by any of the above methods involves removing perc from paper, insoluble soil and an adsorbent consisting of activated carbon and/or clay.

Insoluble soil consists of lint and dust removed from the clothes during washing. It collects as a layer covering the paper and the outer metal portion of the cartridge. The removal of perchloroethylene from this essentially non-adsorbent material is considered to be relatively easy. The paper layer in the filter cartridge has a large surface area, is relatively thin and has little tendency to adsorb perchloroethylene. These properties all combine to allow for the easy removal of perc from the paper. Any of the three listed methods would likely be adequate for removing perchloroethylene from both paper and dirt. The largest quantity of perchloroethylene, however, is adsorbed onto the activated carbon and/or clay which provides a more difficult challenge for solvent removal, since these materials have many small pores and a large surface area which collects and traps the solvent. Most plants can recover at least 3.0 litres of solvent per cartridge, with more efficient operations reclaiming up to 6.0 litres.

Both room temperature air and heated air remove perchloroethylene from the carbon by the same mechanism. The solvent in the carbon is at equilibrium with the perc vapour present in the air directly adjacent to the carbon. As air carries away the vapour, more perc evaporates from the carbon to maintain equilibrium. However, as the carbon starts to dry, there is less perc in the vapour space and the drying process becomes extremely slow. The use of heated air displaces the equilibrium and results in slightly more perc removal, but recovery also becomes extremely slow at lower perc concentrations.

Room Temperature Air

A drying cabinet connected to a carbon adsorber is the main type of equipment used for drying cartridges with ambient air. Air is constantly pulled over the cartridges and then vented to the carbon adsorber. If the carbon adsorber to which this cabinet is connected is sized based only on the dry cleaning equipment, then the addition of a ventilation cabinet would rapidly overload the adsorber causing the perc fumes to merely vent to atmosphere.

Heated Air

The easiest way to dry cartridges using heat is to place them in the air stream of the tumbler/reclaimer or in a dry-to-dry unit. Some manufacturers have claimed that 99.99% recovery of solvent after eight hours of drying in a tumbler/dryer is possible. However, such removal efficiencies have not been observed in practical applications (see Table 5.4).

Azeotroping/Steam Stripping

The third method of recovering solvent from spent cartridges involves the use of steam stripping. The steam initially evaporates and displaces the liquid perc within the cartridge. The heat provided by the steam then flushes away the vapours (which are in equilibrium with the perc in the carbon) in the same manner as with hot air. The steam also forms a lower boiling azeotrope with perc which greatly improves the ease of removal of solvent. An azeotrope is a liquid-vapour mixture of two or more substances which behaves like a single substance. The azeotropic boiling point for perc and water is 190°F, compared to 250°F and 212°F, respectively, for the pure compounds (Dow Company Literature).

One of the simplest steam stripping methods involves placing the cartridges on top of the carbon bed of a carbon adsorber, where they will be stripped with steam during carbon bed regeneration. However, this results in only about 50% removal of the perchloroethylene.

Another method used by some dry cleaners is to place the cartridges in a still and boil them in water until no more perc distills over with the water. This requires large volumes of water and a large still. Perc removal was found to be 95 to 97% complete after seven to ten hours. However, not many old large stills are still available and large volumes of contaminated water are produced.

The direct injection of steam through cartridges in a direction opposite to the solvent flow is an efficient method to remove perchloroethylene from cartridges. The steam flow displaces liquid solvent from the cartridges directly into a condenser/separator.

One supplier manufactures a filter arrangement fitted with accessories to allow stripping of the cartridges directly in the filter housing. This method is very efficient in removing perc with the added advantage that wet cartridges containing perc never have to be handled. The major disadvantage, however, is that filtration cannot be carried out while cartridges are being stripped.

Another manufacturer has developed a combination cartridge stripper and still. Cartridges are placed over tubes from which steam is emitted. Any solvent initially displaced as liquid is distilled by the bottom steam coil of the still. Once the temperature in the cartridge is high enough, perchloroethylene begins to steam distill out of the cartridges as an azeotrope.

4.0 INDUSTRY PROFILE

4.1 Data Sources

A number of different sources were contacted and reviewed to obtain the information required to develop a background profile on the dry cleaning industry.

The first stage in developing the industry profile required the determination of the total number of dry cleaning plants in operation in Ontario. As discussed earlier in Section 2.3.1, Southam Direct Mailing Services provided a list of 1,924 cleaning services within all of Ontario, which was later revised to include only dry cleaning establishments. The final list of 1,316 establishments provides a breakdown of dry cleaners by the six designated MOE regions, along with the name and full address of each establishment. The complete list is given in Appendix 1.

From this list, approximately 300 dry cleaners were randomly chosen and sent a questionnaire to obtain detailed information on their dry cleaning operations. The questionnaires returned provided information on the distribution of plants by size, processing technology, solvent usage, types and quantities of wastes generated, as well as comments from the individual operators on their concerns and questions regarding dry cleaning waste disposal problems. This data was required in order to calculate averages and trends to use in extrapolating to province-wide estimates for the dry cleaning industry.

Communication with the industry association, the Dry Cleaners' and Launderers Institute (DCLI), was maintained regularly. DCLI provided assistance on the make-up of the industry, and participated as an industry information source. Industry statistics calculated by BEAK (such as the total number of dry cleaning plants and the breakdown between solvent types used), were compared to estimates made by the DCLI for the same items. In most cases, the two numbers were within a reasonable range, verifying the validity of results obtained by BEAK.

Solvent manufacturers were contacted to determine the quantity of perchloroethylene sold annually to suppliers, who in turn sell the solvent to the dry cleaners. These figures

were compared to estimates made of the total annual solvent purchases, calculated by extrapolation of values determined from the questionnaires. A check between the two numbers obtained from different sources verified the accuracy of the extrapolation procedures followed.

Information on solvent use practices was also obtained through discussions and on-site visits to selected manufacturers, distributors and dry cleaners. Manufacturers of dry cleaning processing equipment, filter cartridges, solvent recovery systems, and recyclers of still bottom sludges were contacted as well to obtain background information to ensure that all aspects of the dry cleaning operation and its' associated industries were covered. Discussions with knowledgeable industry spokesmen and telephone discussions with several firms provided opinions and perceptions into trends within the industry, estimates on the quantity of equipment sold, as well as other information relevant to this study. The haulers and recyclers of the chlorinated wastes generated by dry cleaning operations were also contacted to verify the answers obtained from the questionnaires, and to obtain their insights into the waste disposal practices of the industry.

4.2 Geographic Distribution by MOE Region

The distribution of dry cleaning establishments by MOE Region is given in Table 4.1. The Central Region, which covers the most densely populated area in Ontario (including Metropolitan Toronto), contains the largest number of dry cleaners, with 64% of the total 1,316 plants located within this area. The Southwestern and West Central region each contain approximately 12%, or 156 dry cleaning plants, while a slightly smaller percentage (3%) operate within the Southeastern region. The Northwestern region contains the fewest number of dry cleaning establishments (less than 20 plants), due to the sparsely populated areas covered by this region (including the counties of Thunder Bay, Rainy River and Kenora). The Northeastern region contains slightly more dry cleaning establishments, with a total of approximately 40 plants in operation, representing 3% of the total number in Ontario. Appendix 1 provides a list of the 1,316 dry cleaners grouped by region.

TABLE 4.1

DISTRIBUTION OF DRY CLEANING
ESTABLISHMENTS BY MOE REGION

MOE Region	Total Number of Plants	Percent Distribution
Southwestern	156	12
West Central	156	12
Central	845	64
Southeastern	102	8
Northeastern	39	3
Northwestern	18	1
	<hr/> 1,316	<hr/> 100%

4.3 Questionnaire Evaluation

A total of 308 questionnaires were mailed out to plants selected from the list of 1,316 Ontario dry cleaning establishments. This represents approximately 23% of the total industry. Table 4.2 indicates the distribution by MOE region of questionnaires mailed out versus questionnaires returned. The selection of plants to receive questionnaires was done on a relatively random basis, except for the intentional selection of the majority of large plants (approximately 40 in total) and the mailing of questionnaires to more than half of the plants in the Northwestern region, to ensure that an adequate response was received from both these areas. An attempt was also made to keep the percentage distribution by MOE region of questionnaires mailed out, as similar as possible to the percentage distribution by MOE region for the total number of dry cleaners.

Of the 308 questionnaires mailed out, 28%, or 85 were returned. However, in some cases, one questionnaire was completed for a number of plants operating under the same

name. Therefore, an actual total of 158 plant responses was received. These 158 plants represent 12% of the total number of dry cleaning plants in Ontario. The majority of dry cleaners responding to the questionnaire were members of the DCLI, even though both DCLI and non-DCLI members were mailed out questionnaires relatively equally. It is also interesting to note that the dry cleaners in the Northeastern and Northwestern regions returned the highest percentage of questionnaires mailed to them (43% and 36% respectively), while the Central region had the poorest response, with only 23% of the dry cleaners responding to the survey.

TABLE 4.2 QUESTIONNAIRE DISTRIBUTION BY MOE REGION

MOE Region	Plant Distribution		Questionnaires Sent Out		Questionnaires Returned		Total Plants Responding	
	Number	%	Number	%	Number	%	Number	%
Southwestern	156	12	36	12	12	14	14	9
West Central	156	12	51	16	15	17	21	13
Central	845	64	163	53	38	45	79	50
Southeastern	102	8	33	11	10	12	30	19
Northeastern	39	3	14	5	6	7	6	4
Northwestern	18	1	11	3	4	5	8	5
	<hr/>	<hr/>	<hr/>	<hr/>	<hr/>	<hr/>	<hr/>	<hr/>
	1316	100	308	100	85	100	158	100

4.3.1 Distribution by Solvent Use

The three types of solvent currently used by the dry cleaning industry include perchloroethylene (perc), petroleum solvent, and fluorocarbons. Table 4.3 gives a breakdown on the quantities of each solvent purchased annually, along with the quantity of dry cleaning processed by each solvent, for the 158 dry cleaners responding to the questionnaire survey.

TABLE 4.3

DISTRIBUTION BY SOLVENT USE OF
DRY CLEANING ESTABLISHMENTS SURVEYED

Solvent	Dry- Cleaning Plants #	%	Annual Solvent Purchases (litres)	Annual Dry Cleaning Processed (kg)	Percent of Dry Cleaning Processed By Solvent Type
<u>Perchloroethylene (Perc):</u>					
Plants using only Perc	141	89.2	1,037,000	9,967,000	76.7
Plants using Perc + PS	8	5.1	32,000	473,000	3.7
	<hr/> 149	<hr/> 94.3 *	<hr/> 1,069,000	<hr/> 10,440,000	<hr/> 80.4
<u>Petroleum Solvent (PS):</u>					
Plants using only PS	8	5.1	125,500	386,600	3.0
Plants using PS + Perc	8	5.1	784,000	2,134,000	16.4
Plants using PS + FC	1	0.6	2,500	5,500	0.04
	<hr/> 17	<hr/> 10.8 *	<hr/> 912,000	<hr/> 2,526,100	<hr/> 19.44
<u>Fluorocarbon (FC):</u>					
Plants using FC + PS	1 +	0.6 *	800 kg **	22,000	0.2
				<hr/> 12,988,100	<hr/> 100.0

* Percentage of dry cleaning plants utilizing a particular type of solvent calculated using the total number of plants responding to the questionnaire survey (158 from Table 4.2).

** Fluorocarbons sold on a weight basis while perc and PS sold on a volume basis.

+ DCLI indicates only about 3 plants using FC in all of Ontario.

Of the 158 plants surveyed, 94.3% use perchloroethylene, 10.8% use petroleum solvent, and 0.6% use a fluorocarbon (trade name Valclene). The sum of the percentages totals greater than 100%, since some of the plants surveyed use 2 types of solvent and will therefore be counted twice. For example, of the 158 plants, 141 use only perchloroethylene, 8 use only petroleum solvent, 8 use both perchloroethylene and petroleum solvent, while only one uses both petroleum solvent and Valclene (fluorocarbons).

According to a MOL Study (1982), perchloroethylene is used in 80 to 90% of the dry cleaning establishments, with petroleum solvent making up the remaining 10 to 20 percent. Fluorocarbons are only used in approximately three plants in all of Ontario (based on DCLI information), representing about 0.2% of the total numbers of plants. The number of dry cleaners currently using Stoddard's solvent has likely decreased below the range given by the 1982 MOL study, due to the fact that many plants are replacing their old transfer units with new hot or refrigerated perc units. The values obtained from the questionnaire on the breakdown between solvent usage can therefore be considered as representative of the total industry.

The 17 plants using petroleum solvent account for about 19% of all the dry cleaning processed, even though these plants represent only 11% of the 158 plants surveyed, whereas the 94% of the plants utilizing perchloroethylene process only 80% of all the dry cleaning. The reason for this imbalance is due to the inclusion of one very large petroleum solvent plant which services a multitude of depots and does substantially more dry cleaning than any other large plant in the province. Of the total 12,988,100 kg of dry cleaning processed by the plants responding to the survey, over 13% was cleaned by this one large plant. If this figure is excluded from the totals, then the perchloroethylene plants, which represents 94% of the total plants, would process about 93% of the dry cleaning while the petroleum solvent plants would process about 7%.

4.3.2 Distribution by Technology and Plant Size

4.3.2.1 Distribution by Plant Size

Dry cleaning plants can be categorized into groupings based on the size of each plant and the type of processing technology used. On the basis of discussions with DCLI, and upon

review of the questionnaires, it was decided to breakdown the dry cleaning establishments into either a small, medium or large category using the following criteria:

- Small Plant - Less than 3,000 kg of dry cleaning processed monthly (less than 36,000 kg/yr)
- Medium Plant - From 3,000 to 7,500 kg of dry cleaning processed monthly (36,000 to 90,000 kg/yr)
- Large Plant - More than 7,500 kg of dry cleaning processed monthly (greater than 90,000 kg/yr)

Table 4.4 gives a detailed distribution of dry cleaning establishments using this sizing criteria.

A further breakdown of plant size can be made on the basis of the number of persons employed in the dry cleaning establishment. As estimated by the DCLI, a small establishment is designated as a plant employing from 1 to 10 persons. The DCLI also defines a medium plant as one employing from 11 to 50 persons, while large plants are classified as those employing more than 50. These size designations are equivalent to the monthly processing ranges given above.

There are approximately 40 large plants in Ontario which represent about 7% of the total dry cleaning industry. Virtually all these large plants are members of the DCLI. The majority of the DCLI membership (which totals approximately 600 plants), however, is comprised of small establishments, representing 75 to 80% of the total members. The DCLI estimates that this size range also constitutes a similar percentage of non-DCLI members, with the remaining 17-22% consisting of medium-sized plants.

The results from the questionnaires indicate that 58 plants, or 37% of the plants surveyed, fall into the small category. This percentage is substantially lower than the DCLI estimate of 75 to 80%. There are two probable reasons for this discrepancy. One is that 37 of the estimated 40 large plants returned a questionnaire, making the averages more heavily weighted towards the large plants than would actually be the case when considering the total number of plants over the entire province.

TABLE 4.4

DISTRIBUTION BY SIZE OF
DRY CLEANING ESTABLISHMENTS SURVEYED

Solvent Used	Size Distribution						Total Number of Plants
	Small		Medium		Large		
	Number	% (1)	Number	% (2)	Number	% (3)	
Perchloroethylene Only	50	86	59	94	32	86	141
Petroleum Solvent Only	4	7	3	5	1	3	8
Perchloroethylene and Petroleum Solvent	3	5	1	1	4	11	8
Valclene and Petroleum Solvent	1	2	-	-	-	-	1
	<hr/>	<hr/>	<hr/>	<hr/>	<hr/>	<hr/>	<hr/>
	58	100	63	100	37	100	158

Note: Small - Less than 3,000 kg of dry cleaning processed monthly
Medium - 3,000 to 7,500 kg of dry cleaning processed monthly
Large - More than 7,500 kg of dry cleaning processed monthly

(1) - % - Based on total number of small plants (58)

(2) - % - Based on total number of medium plants (63)

(3) - % - Based on total number of large plants (37)

Also, smaller establishments, often referred to as "mom and pop" operations (in reference to a family-run business), would be less inclined to answer a survey than larger establishments which tend to be more aware of disposal concerns and therefore more willing to assist by answering a questionnaire survey. It therefore appears likely that the percentage estimate of plant size distribution as given by the DCLI is valid and can be used for extrapolating to province-wide values in subsequent sections of this report.

4.3.2.2 Distribution by Processing Technology

Table 4.5 gives a further breakdown of plant size by processing technology. Most of the plants surveyed use only one type of processing technology, although 8% (or 12 plants) utilize two or all three types of processing in their dry cleaning plant. Of the plants surveyed, transfer is the most commonly used dry cleaning technology, with 71% of the small plants, 57% of the medium, and 57% of the large plants employing this process. This represents 62% of the total 158 plants which use the transfer process. As indicated in Table 4.6, almost 60% of the dry cleaning is processed using transfer technology, with the majority done by large plants. As mentioned earlier, this value is probably slightly high due to the inclusion of one very large petroleum solvent transfer plant which would tend to unbalance the averages.

Hot technology is used by 34% of the small plants, 29% of the medium plants, and 49% of the large plants, giving an overall average of 37% when the total 158 plants are taken into consideration. The 56 plants utilizing hot technology process approximately 34% of the annual dry cleaning carried out by the plants surveyed. Refrigerated plants account for approximately 11% of the total number of establishments, accomplishing over 6% of the total dry cleaning processed. Most of the refrigerated plants fall into the medium-size range, with only one large refrigerated plant responding to the questionnaire.

TABLE 4.5 DISTRIBUTION BY PROCESSING TECHNOLOGY AND SIZE OF DRY CLEANING ESTABLISHMENTS SURVEYED

Processing Technology	Dry Cleaning Small		Size Distribution Medium				Large		Dry Cleaning Plants	
	Number	% 1	Number	% 2	Number	% 3	Number	% 3	Number	%
<u>Transfer Only</u>										
Perc	30	51.7	32	50.8	15	40.5	77	48.7		
PS	4	6.9	3	4.8	1	2.7	8	5.1		
Perc + PS	-	-	1	1.6	-	-	1	0.6		
Sub-Total	34	58.6	36	57.2	16	43.2	86	54.4		
<u>Hot Only</u>										
Perc	15	26.0	18	28.5	15	40.5	48	30.4		
<u>Refrigerated Only</u>										
Perc	2	3.4	9	14.3	1	2.7	12	7.6		
<u>Transfer & Hot</u>										
Perc	2	3.4	-	-	1	2.7	3	2.0		
PS(Tr) + Perc(Hot)	3	5.2	-	-	1	2.7	4	2.5		
Sub-Total	5	8.6			2	5.4	7	4.5		
<u>Transfer & Refrigerated</u>										
Perc	1	1.7	-	-	-	-	1	0.6		
PS(Tr) + Perc(Refrig)	-	-	-	-	2	5.4	2	1.3		
PS(Tr) + FC(Refrig)	1	1.7	-	-	-	-	1	0.6		
Sub-Total	2	3.4			2	5.4	4	2.5		
<u>Transfer, Hot & Refrigerated</u>										
PS(Tr) +	-	-	-	-	1	2.7	1	0.6		
Perc(Hot, Refrig)										
TOTALS	58	100.0	63	100.0	37	100.0	158	100.0		

- 1- % based on total number of small plants (58)
 2- % based on total number of medium plants (63)
 3- % based on total number of large plants (37)

Perc = perchloroethylene
 PS = petroleum solvent
 TR = transfer technology
 FC = fluorocarbon

An efficiency parameter of interest is the solvent "mileage", calculated as litres of solvent used per 1000 kg of dry cleaning processed (or lbs of process per gallon). Values for the different technologies have been quoted (DCLI) as:

<u>SOLVENT MILEAGE</u>			<u>TECHNOLOGY</u>
40 to 50	L/1000 kg	(200 to 250 lbs/gallon)	Transfer
20 to 25	L/1000 kg	(400 to 500 lbs/gallon)	Hot
10 to 13	L/1000 kg	(800 to 1000 lbs/gallon)	Refrigerated

for perchloroethylene plants. However, as seen in Table 4.7, the range of solvent mileage obtained can vary substantially, and is generally higher than the DCLI estimated. Perchloroethylene mileage at large plants is within the range as quoted by the DCLI. Medium and small plants, however, appear to use 2 to 5 times the solvent per 100 kg of dry cleaning estimated by DCLI.

Certain general observations can be made on the solvent usage per 1000 kg of dry cleaning. Solvent use decreases (i.e., becomes more efficient) when going from transfer, to hot, to refrigerated technology. Solvent use decreases in going from small to medium to large plants. An average for solvent usage in large refrigerated plants was not obtained since only one large refrigerated plant responded. The range of solvent mileage is particularly diverse for small and medium transfer plants. This large variability is due in part to the various ways in which different operators transfer clothing from one machine to another, i.e., clothing may have most of the solvent extracted through an adequate spin cycle, whereas some operators may remove clothing still dripping with solvent.

Petroleum solvent plants have much higher values of solvent usage than equivalent perchloroethylene transfer plants. Perchloroethylene is approximately three times more expensive than petroleum solvent, leading to a greater incentive to recover perchloroethylene. Petroleum solvent transfer machines are also usually older than the equivalent perchloroethylene transfer machines, with solvent losses occurring through parts of the machine which may have become worn down through prolonged use.

TABLE 4.6

DISTRIBUTION OF DRY CLEANING ESTABLISHMENTS SURVEYED BY
PROCESSING TECHNOLOGY, SOLVENT USE AND QUANTITIES OF DRY CLEANING PROCESSED

SIZE DISTRIBUTION

	SMALL			MEDIUM			LARGE			Annual		
	No. of Plants	Kg of Dry Cleaning Processed/yr	Solvent Use L/yr	No. of Plants	Kg of Dry Cleaning Processed/yr	Solvent Use L/yr	No. of Plants	Kg of Dry Cleaning Processed/yr	Solvent Use L/yr	Dry Cleaning Plants #	Dry Cleaning % 1	Quantity of Dry Cleaning Processed (kg) % 1
<u>Transfer</u>												
Perchloroethylene	33	752,000	67,000	35	2,518,000	629,000	15	1,292,000	85,000	83	53	5,262,000 40.5
Petroleum Solvent	10	125,100	42,000	4	270,000	75,000	3	2,131,000	795,000	17	11	2,526,100 19.5
												60.0
<u>Hot</u>												
Perchloroethylene	22	437,000	29,000	18	917,000	49,000	16	3,037,000	190,000	56	35	4,391,400 33.8
<u>Refrigerated</u>												
Perchloroethylene	4	74,000	2,000	11	557,000	19,000	1	136,000	9,000	16	10	787,000 6.1
Fluorocarbon	1	22,000	800 kg	-	-	-	-	-	-	1	0.6	22,000 0.1
												800 kg
OVERALL TOTAL:												12,988,100 100

Percentage based on total number of plants (138) responding to questionnaire.

TABLE 4.7

SOLVENT USAGE BY PROCESSING TECHNOLOGY AND
SIZE FOR DRY CLEANING ESTABLISHMENTS SURVEYED

SIZE DISTRIBUTION

PROCESSING TECHNOLOGY	Small			Medium			Large		
	No. of Plants	Solvent Usage L/1000 kg (lbs/gal)		No. of Plants	Solvent Usage L/1000 kg (lbs/gal)		No. of Plants	Solvent Usage L/1000 kg (lbs/gal)	
		Avg.	Range		Avg.	Range		Avg.	Range
TRANSFER	33	100 (100)	29-292 (41-365)	35	87 (115)	33-401 (25-303)	15	48 (26.3)	30-44 (227-333)
	10	422 (26)	84-1116 (9-419)	4	280 (36)	129-455 (22-78)	3	332 (30)	273-392 (26-37)
HOT	22	39 (256)	17-209 (48-588)	18	99 (204)	17-96 (106-588)	16	42 (238)	17-92 (109-588)
REFRIGERATED	4	29 (365)	8-59 (169-1250)	11	23 (435)	6-74 (135-1667)	1	67 (169)	

TABLE 4.8

DISTRIBUTION OF DRY CLEANING
ESTABLISHMENTS SURVEYED BY SOLVENT
CONDITIONING/RECOVERY TECHNOLOGY AND SIZE
PERCHLOROETHYLENE PLANTS

Technology	Size Distribution						Dry Cleaning Plants		No. of Units In Use
	Small		Medium		Large		#	% ⁴	
	#	% ¹	#	% ²	#	% ³			
<u>Solvent Conditioning:</u>									
o Distillation Units:	40	75	60	100	30	83	130	88	170
o Diatomaceous Earth Filtration:	4	8	5	8	7	19	16	11	18
o Cartridge Filters:	47	89	55	92	34	94	136	136	91
Standard - Carbon Core	39	74	29	48	21	58	89	60	757 ⁴⁶
- All Carbon	12	23	28	47	19	53	59	40	1446
- Paper	6	11	6	10	-	-	12	8	389
Jumbo - Carbon Core	5	9	24	40	6	17	35	23	395 ⁷
- All Carbon	7	13	11	18	1	3	19	13	340
- Paper	-	-	1	2	-	-	1	0.7	47
- Adsorptive	12	23	4	7	18	50	34	23	1074
<u>Solvent Recovery:</u>									
o Solvent Reclaim Tumblers:	36	68	26	43	31	86	93	59	135
o Cartridges:									
- No Recovery	19	38	16	29	1	3	36	27 ⁵	2180 ⁶
- Drain	9	18	1	2	1	3	11	8	788
- Tumbler Dry	4	8	1	2	1	3	6	4	481
- Cabinet/Sniffer	12	24	19	35	25	81	56	41	884 ⁷
- Drain Plus Steam Strip	2	4	3	5	3	10	8	6	1283
- Cab/Sniffer Plus Steam Strip	4	8	15	27	-	-	19	14	1248

Note:

- 1 - % based on total number of small plants (53) using perchloroethylene
- 2 - % based on total number of medium plants (60) using perchloroethylene
- 3 - % based on total number of large plants (36) using perchloroethylene
- 4 - % based on total number of plants (149) using perchloroethylene
- 5 - % based on total number of plants using cartridge filters
- 6 - Total indicates number of cartridges used yearly

DISTRIBUTION OF DRY CLEANING
ESTABLISHMENTS SURVEYED BY SOLVENT
CONDITIONING/RECOVERY TECHNOLOGY AND SIZE
PETROLEUM SOLVENT PLANTS

Technology	Size Distribution						Dry Cleaning Plants		No. Of Units In Use
	Small # % ¹		Medium # % ²		Large # % ³		#	% ⁴	
<u>Solvent Conditioning:</u>									
o Distillation Units:	5	63	3	75	2	40	10	59	12
o Diatomaceous Earth Filtration:	3	38	1	25	1	20	5	29	15
o Cartridge Filters:	8	100	4	100	3	60	15	88	
Standard - Carbon Core	4	50	1	25	-	-	5	29	3026
- All Carbon	2	25	1	25	1	20	4	24	1047
- Paper	-	-	-	-	1	20	1	6	1000
Jumbo - Carbon Core	1	13	1	25	2	40	4	24	339
- All Carbon	1	13	-	-	1	20	2	12	45
- Paper	-	-	-	-	1	20	1	6	142
- Adsorptive	2	25	2	50	1	20	5	29	239
<u>Solvent Recovery:</u>									
o Solvent Reclaim Tumblers:	-	-	2	50	1	20	3	18	5
o Cartridges:									
- No Recovery	7	88	2	50	2	67	11	73.5	26766
- Drain	1	12	1	25	-	-	2	13.5	142
- Tumbler Dry	-	-	-	-	-	-	-	-	-
- Cabinet/Sniffer			1	25	1	33	2	13.5	296
- Steam Strip	-	-	-	-	-	-	-	-	-
- Cab/Sniffer Plus Steam Strip	-	-			-	-			
<p>Note:</p> <p>1 - % based on total number of small plants (8) using petroleum solvent</p> <p>2 - % based on total number of medium plants (4) using petroleum solvent</p> <p>3 - % based on total number of large plants (5) using petroleum solvent</p> <p>4 - % based on total number of plants (17) using petroleum solvent</p> <p>5 - % based on total number of plants using cartridge filters</p> <p>6 - Total indicates number of cartridges used yearly</p>									

4.3.2.3 Distribution by Solvent Conditioning/Recovery Technology

Tables 4.8 and 4.9 give the distribution of dry cleaning establishments by solvent conditioning/recovery technology and size for perchloroethylene plants and petroleum solvent plants, respectively.

Perchloroethylene

The majority of the plants which use perchloroethylene operate both distillation units and cartridge filters. Eighty-eight percent of the perc plants use stills, with 170 units used by 130 plants. Cartridge filters are used in 91% of the plants, with the standard size carbon core filter the most frequently used type. The first column in the table indicates the number of dry cleaning plants which use a particular technology. In the case of cartridge filters, the total number of plants using cartridges is not equal to the sum of the number of plants using a particular cartridge type. This is because some plants may use up to 3 types of cartridges in their operations. Diatomaceous earth filtration is used in only 16 of the perchloroethylene plants surveyed, corresponding to 11% of the total plants. The largest percentage of diatomaceous earth filters are operated in large plants, where 19% utilize this filter type for solvent conditioning. There is a higher percentage in the large plants since one major chain, which runs a number of large plants, uses diatomaceous earth filters in many of its dry cleaning establishments.

Solvent recovery from spent cartridges containing perchloroethylene is most commonly done using a cabinet/sniffer arrangement. Forty-one percent of the plants surveyed used this recovery method, which consists of placing the cartridges in an enclosed cabinet which is hooked up to a carbon adsorber. Hot air is forced through the cabinet and subsequently to the "sniffer" which adsorbs the perchloroethylene from the air. Cartridges are generally left in the cabinet for an average 5 to 7 days.

Twenty-seven percent of the perchloroethylene plants which use cartridge filters do not practice any form of recovery of solvent from the filters. The cartridges are removed from the filter housing and disposed of directly to the municipal refuse. It is surprising that so many plants follow this procedure when allowing the cartridges to drain for 24 hours could recover several litres per cartridge of solvent, with no additional equipment being required. Only 8% of the plants recover perchloroethylene by draining the cartridge.

Twenty percent of the plants practice steam-stripping of the cartridges, which is considered to be the best method to remove the maximum amount of perchloroethylene in the shortest span of time. Cartridges are either first drained or placed in a cabinet/sniffer arrangement prior to being steam-stripped.

The recovery of perchloroethylene by drying the filter cartridges in the tumbler is only practiced in 4% of the plants utilizing filters. Most of the small plants which use cartridge filters, totalling 38%, practice no recovery of perchloroethylene from the filters. This percentage drops as the size of the plant increases - only 3% of the large plants practice no solvent recovery. This is likely due to the fact that most large plants are more aware of the economics involved in solvent recovery, and would generally run a more efficient operation than a small plant, as was clearly indicated in Table 4.7 on solvent usage by plant size.

Petroleum Solvent

Only 53% of the petroleum solvent plants use distillation units. All the medium-sized plants surveyed had stills, whereas only 20% of the large and 38% of the small plants had distillation systems. As mentioned in Section 3.0, petroleum solvent plants require vacuum distillation units which are more expensive than the counterpart stills used in perchloroethylene plants. Due to this fact, many operators of petroleum plants forego the distillation of the solvent.

Diatomaceous earth filtration is used more frequently in petroleum plants than in perchloroethylene plants. Most petroleum solvent plants tend to be older establishments, and diatomaceous earth filters were commonly used in such plants. The newer perc plants would tend to use cartridge filters before selecting the use of diatomaceous earth filtration. In addition, diatomaceous earth filters can no longer be bought as individual free standing units in North America. These filters can only be bought as part of a refrigerated unit.

Cartridge filters, however, are the predominant form of filtration used in petroleum solvent plants, as was the case with perchloroethylene plants. Jumbo adsorptive filters and standard carbon-core filters are used by 29% of the petroleum plants, while the use of standard all-carbon and Jumbo carbon-core filters followed closely at 24%. This represents a different distribution than that seen in perchloroethylene plants, where twice as many dry cleaners used standard carbon core over jumbo carbon core and jumbo adsorptive cartridges.

Seventy-three percent of the petroleum plants using filter cartridges practice no recovery of solvent from the filters. Since petroleum solvent is relatively inexpensive, dry cleaners will not go to much effort to recover any solvent. The only other two recovery methods practiced by the dry cleaners surveyed were draining of the cartridges, and recovery through a cabinet/sniffer.

Only 18% of the plants using petroleum solvent use reclaiming tumblers. Most plants use conventional type tumblers which simply vent outside the building.

Table 4.10 gives a more detailed breakdown of solvent conditioning technologies by solvent use, size and type of processing technology employed, versus the amount of dry cleaning processed. It should be noted that the figures presented in Table 4.10 on the number of plants per category will not necessarily total those as given previously in Tables 4.8 and 4.9. In Table 4.10, one plant may be included in up to 3 different categories, depending on the different types of processing technology used within the plant. In addition, plants using more than one type of processing technology which are also listed as large establishments in Tables 4.8 and 4.9, may be classified as small or medium-sized plants when broken down by individual processing technologies.

The annual quantity of cleaning processed presented in Table 4.10 will not total 12,988,100 kg as it does in Table 4.6. This is due to the fact that for some plants, quantities may be counted twice if 2 different types of solvent conditioning methods are practiced.

4.3.3 Distribution by Waste Generation

Perchloroethylene plants and petroleum solvent plants can produce up to three types of waste each, depending on the type of plant operations employed. These wastes include still bottom residues from solvent distillation, spent cartridge filters, and filter muck from diatomaceous earth filtration. Dry cleaners utilizing fluorocarbons can potentially generate only two types of wastes - still bottom sludges and spent cartridge filters. However, the quantities of fluorocarbon wastes generated in Ontario are very small due to the limited number of operations using this type of cleaning solvent.

4.3.3.1 Still Bottom Sludges

Table 4.11 lists the quantity of still bottom sludges disposed of annually by the dry cleaners surveyed, along with the disposal method used.

The majority of the dry cleaners surveyed store the still bottoms on-site in 45 gallon drums until a number of these containers have accumulated. The sludge is then submitted for off-site redistillation and recovery of solvent. Ninety-nine percent of the sludge containing perchloroethylene is disposed of in this manner. This is equivalent to 208,300 kg of sludge per year.

In some cases, however, the nature of the material (black, oily sludge) may lead to the "easiest" solution of disposal with the plant refuse, especially in smaller plants where quantities produced are not excessive. Overall, less than 1% of the plants surveyed disposed of still bottoms in this manner. However, 13% of the small plants use this method, while no large plants disposed of sludges to the refuse. One medium-sized plant is stockpiling the still bottom sludges until a disposal method is decided upon.

The majority of sludges from petroleum solvent plants (97%) are hauled to industrial landfill sites for disposal, while 2% dump their sludges into regular municipal refuse. Again, the smaller establishments tend to be more likely to dispose of their sludges into the municipal refuse than larger plants would be. Two plants, generating 1% of the total quantity of petroleum solvent sludges, are currently stockpiling their still bottoms until a decision is reached on how to ultimately dispose of their wastes.

TABLE 4,10
DISTRIBUTION OF SOLVENT CONDITIONING TECHNOLOGY IN DRY CLEANING ESTABLISHMENTS SURVEYED BY
PROCESSING TECHNOLOGY, SOLVENT USE AND SIZE

[illegible]

¹ Percentage based on total number of plants (158) responding to questionnaire.

2 Percentage based on total quantity of dry cleaning processed by plants responding to questionnaire (Table 4.3 = 12,988,100 kg/yr).

TABLE 4.11

QUANTITY OF STILL BOTTOM SLUDGES DISPOSED OF
YEARLY BY DRY CLEANING ESTABLISHMENTS SURVEYED

Processing Technology	SIZE DISTRIBUTION					LARGE	Total No. of Plants	Total Quantity (kg/yr)	Disposal Method	Total Quantity (kg/yr)	Disposal Method	
	SMALL		MEDIUM		No. of Plants							Disposal Method
	No. of Plants	Quantity (kg/yr)	No. of Plants	Quantity (kg/yr)								
Pentachloroethylene												
Transfer	11	2,200	recyclers	31	61,800	recyclers	14	23,600	recyclers	56	87,600	
	1	900	refuse	1	300	refuse	2	600	refuse	2	600	
Hot	13	4,500	recyclers	6	8,700	recyclers	14	98,200	recyclers	32	111,400	
	2	800	refuse	1	300	refuse	3	1,100	refuse	3	1,100	
Refrigerated	3	1,000	recyclers	10	5,200	recyclers	1	3,100	recyclers	19	9,300	
TOTAL	27	7,700	recyclers	67	75,700	recyclers	29	129,900	recyclers	103	208,300	
	3	1,100	refuse	2	600	refuse	5	1,700	refuse	5	1,700	
		8,800		1	76,900	stockpiling		129,900	stockpiling	1	600	
Petroleum												
Transfer	1	1,300	industrial landfill		-	-	2	66,300	industrial landfill	3	67,600	
	2	1,000	refuse	2	500	refuse	-	-	refuse	4	1,400	
	2	600	stockpiling		-	-	-	-	-	2	600	
TOTAL	5	2,900		2	400		2	66,300				
Household												
Refrigerated	1	1,000	hard to U.S. for incineration		-	-	-	-	-	1	1,000	
											hard to U.S. for incineration	

The one plant using fluorocarbons which responded to the survey hauls its still bottom sludges to the United States for incineration, since no such facilities are available in Ontario.

4.3.3.2 Filter Muck

The quantity of filter muck generated by the dry cleaners surveyed and the ultimate disposal method practiced is given in Table 4.12.

Cooked filter muck is most commonly disposed of with municipal refuse. Nine of the sixteen perchloroethylene plants surveyed disposed of their wastes in this manner, although this accounts for only 29% of the total quantity of cooked filter muck generated annually.

Only one major dry cleaning chain in the province has their perchloroethylene filter muck picked up by a licensed hauler who transports the wastes to a chemically secure landfill site in Sarnia. There are seven plants operating under this chain which use diatomaceous earth filtration and generate 71% of the total quantity of filter muck disposed of by plants in this survey.

Most of the filter muck generated by petroleum solvent plants comes from one large plant, which generates almost 99% of the total quantity, and disposes of its muck to the industrial landfill site. The remaining 1% of the filter muck, disposed of by 4 plants, is thrown away with regular municipal refuse.

4.3.3.3 Cartridge Filters

Table 4.13 presents the quantity of filter cartridges disposed of yearly by the dry cleaning establishments surveyed. The table gives a breakdown by cartridge size of the ultimate disposal method used.

Most perchloroethylene plants dispose of their filter cartridges with the municipal refuse. Only 5 plants have their cartridges hauled to an industrial landfill site. Of these 5 plants, 3 are small operations.

Sixty-four percent of spent cartridges containing perchloroethylene are standard size, with the carbon core cartridge the most common. The remaining 36% consist of the jumbo size, with the carbon-core cartridge again the most predominant type. As would be expected, the majority of cartridges disposed of, totalling 83%, came from the medium and large sized plants.

Of the 15 petroleum solvent plants surveyed which use cartridge filters, 13 dispose of their cartridges with the municipal refuse. This, however, only accounts for 34% of the total spent cartridge filters. There is one large plant which generates 64% of the total cartridge filters requiring disposal. Standard all-carbon and standard plain paper cartridges make up this 64%. Along with other medium size plants, this large plant has its spent cartridges hauled away to a chemically secure landfill site.

4.3.4 Concerns/Trends of the Dry cleaning Industry

There were a number of issues of concern and noticeable trends that surfaced during the evaluation of the questionnaires, and upon discussions with individuals and manufacturers/suppliers of dry cleaning equipment.

The major concern voiced by most dry cleaners is the expected cost increases associated with the extra treatment/disposal of filter cartridges that would be required if cartridges were listed as a hazardous material. Many feel that if regulations are brought in too swiftly, many small dry cleaners could not cope with the expense and would ultimately go out of business. Some plants are even discontinuing the use of cartridges and are using only stills in an attempt to avoid the problem of cartridge disposal. One dry cleaner suggested that taxes and import duties be removed from solvent reclaim equipment to make these units more affordable to the dry cleaning industry.

On the questionnaire survey, the dry cleaners were polled as to what action they would take if their waste was considered hazardous and required special disposal methods. Approximately 42% of the dry cleaners indicated they would use industrial waste haulers, due to the convenience and ready availability of haulers. Others picked this method as the easiest, since many were confused and somewhat intimidated by the different types of equipment available on the market, and the often conflicting claims made by the manufacturers of such equipment.

Twelve percent of the dry cleaners indicated they would send their wastes to solvent recyclers, 19% said they would purchase equipment to render their wastes non-hazardous, while 17% would buy equipment which would reduce the quantity of wastes generated. The remaining 10% felt they could not handle such a financial strain and would sell or go out of business.

Many of the dry cleaners polled seemed to be more than willing to comply with any regulations set forth by the Ministry of the Environment. Most, however, wanted the exact procedures stipulated, along with the specifications as to the exact type of equipment required, so as to avoid any possible confusion that may arise by claims from different manufacturers of different equipment.

Dry cleaners who practice steam stripping of their cartridges generally feel that the filters are suitable for landfill disposal. The weight of the cartridge upon removal from the steam stripper is usually only slightly more than the weight of the cartridge new, indicating that only slight quantities of solvent would be present. One major chain is set to purchase steam stripping units for its plants, but is waiting until the final word from the MOE prior to making a final decision. Other dry cleaners who are currently using a cabinet/sniffer arrangement are also making plans to switch to stream stripping, not only to follow any regulations that may be enacted, but also to recover more perchloroethylene.

One small operator, who said he could not afford the cost of a steam stripper since he would only use it 3 times a year, is making arrangements to use the sparging unit of a larger dry cleaner in his area. With this arrangement, the smaller operator would pay a fee to the larger dry cleaner each time he required the stripping of his cartridges. In this way, both dry cleaners gain from the arrangement. There are, however, certain problems arising from this arrangement. Moving spent cartridges from one plant to another would require registration under Regulation 309. As well the receiver of the cartridge would then require a certificate of approval to become an operator of a waste management system under Regulation 309.

One major trend seen to be occurring in the dry cleaning industry is the increase in the use of refrigerated units. One supplier of equipment noted that approximately 85% of the dry cleaning machines sold in the past year were refrigerated. This trend is expected to continue as solvent cost increases, and there is more concern for worker health. One major spokesman for the DCLI also indicated that there is a new type of diatomaceous earth filtration unit that is currently being used in Europe, which is much more efficient and easier to use than cartridge filters. This improved filtration system could find a potential market in Ontario if cartridge filters become regulated.

4.4 Quality of Data Base

The 158 plants responding to the survey correspond to approximately 12% of the total number of dry cleaners in Ontario. As was seen in Table 4.2 in an earlier section, the proportion of responses by MOE region is approximately similar to the proportion by region for the total 1316 plants. Also, a sufficient number of responses were received for each type of processing technology, solvent use and size to give relevant information in each area. The only exception is for fluorocarbon plants where only one response was received. This was expected since there are only a few plants in Ontario which use fluorocarbon as the cleaning solvent.

Estimates determined in this study for certain items such as the total number of dry cleaning plants and the breakdown between solvent types were comparable with estimates provided by the DCLI, which confirms the validity of results obtained. Further comparisons on the breakdown by solvent type were made with a Ministry of Labour Study (1982) which indicated 10 to 15% of all Ontario dry cleaners use petroleum solvent. This correlated well with data obtained in this study indicating around 11% petroleum solvent plants.

4.5 Solvent Use

Dow Chemical of Canada Ltd. and CIL Inc. supply virtually all the perchloroethylene used in Ontario dry cleaning establishments. These two companies have the only Canadian facilities available to manufacture perchloroethylene. Dow Chemical produces perchloroethylene in Sarnia, Ontario, while all CIL Inc. solvents are formulated in

Shawinigan, Quebec. There may be small volumes of solvent (a couple of tanker cars) which are supplied by U.S. based manufacturers. However, these quantities were not quantified and would represent a very small share of the total market. The perchloroethylene is distributed to Ontario dry cleaners by seven major distributors.

Based on 1986 data provided by Dow and CIL, it was determined that a total of 2,128,000 to 2,241,000 litres a year of perchloroethylene was supplied to Ontario dry cleaners. This data should be interpreted as a reasonable indicator of solvent use rather than a precise quantity of actual use.

According to a Ministry of Labour study, 2,800,000 litres of perchloroethylene was consumed by the dry cleaning industry in 1982. The 1986 figure is somewhat less, likely due in part to an increased awareness of solvent recovery methods, including the increase in use of the refrigeration process.

Although the two main manufacturers of petroleum solvent were contacted, neither was willing to divulge volumes of solvent sold annually to dry cleaners. No actual figures of province-wide usage of petroleum solvent is therefore available. However, an estimate of usage was obtained in Chapter 6.0 using averages calculated from the questionnaire survey.

TABLE 4.12

QUANTITY OF DIATOMACEOUS EARTH FILTER MUCK DISPOSED OF
YEARLY BY DRY CLEANING ESTABLISHMENTS SURVEYED

SIZE DISTRIBUTION

	SMALL			MEDIUM			LARGE		
	No. of Plants	Quantity (kg/yr)	Disposal Method	No. of Plants	Quantity (kg/yr)	Disposal Method	No. of Plants	Quantity (kg/yr)	Disposal Method
Petroleum Solvent									
Transfer	3	700	refuse	1	100	refuse	-	-	refuse industrial landfill
Hot	1	200	refuse	2	5,000	refuse	5	11,800	refuse industrial landfill
Refrigerated	-	-	-	2	1,000	refuse	2	5,300	refuse industrial landfill
TOTAL	4	900	refuse	5	6,100	refuse	7	17,100	refuse industrial landfill
							16	29,100	
Petroleum Solvent	3	900	refuse	1	100	refuse	1	90,200	industrial landfill
TOTAL	5	91,200							

TABLE 4.13 QUANTITY OF FILTER CARTRIDGES DISPOSED OF YEARLY BY DRYCLEANING ESTABLISHMENTS SURVEYED

SIZE DISTRIBUTION

Processing Technology	Small			Medium			Large			Total No. Plants	# Cartridges Standard Jumbo	Disposal Method	Disposal Method		
	No. of Plants	# Cartridges Standard	Jumbo	No. of Plants	# Cartridges Standard	Jumbo	No. of Plants	# Cartridges Standard	Jumbo						
<u>Percbloroethylene</u>															
Transfer	27 1	980 100	310 -	12	1,545 -	3,085 -	Refuse Industrial Landfill	40	2,345 -	600 -	Refuse Industrial Landfill	69 1	4,820 100	3,995 -	Refuse Industrial Landfill
Hot	15 2	680 80	105 -	15	760 -	145 -	Refuse Industrial Landfill	15	2,450 -	715 -	Refuse Industrial Landfill	45 3	3,570 80	965 965	Refuse Industrial Landfill
Refrigerated	2 1	225 85	50 -	7	430 -	65 -	Refuse Industrial Landfill	1 1	50 85	160 -	Refuse Industrial Landfill	10 1	705 85	275 -	Refuse Industrial Landfill
TOTAL	44 3	1,885 180	465 -	34 1	2,715 85	3,295 -	Refuse Industrial Landfill	33 1	4,595 -	1,475 190	Refuse Industrial Landfill	131 5	9,145 265	5,325 190	Refuse Industrial Landfill
<u>Petroleum Solvent</u>															
Transfer	47 8	2,065 200	465 90	55 3	2,800 145	3,295 200	Refuse Industrial Landfill	34 1	4,595 2000	1,665 430	Refuse Industrial Landfill	136 2	9,410 2000	5,425 50	Refuse Industrial Landfill
TOTAL	47 8	2,065 200	465 90	55 3	2,800 145	3,295 200	Refuse Industrial Landfill	34 1	4,595 2000	1,665 430	Refuse Industrial Landfill	136 2	9,410 2000	5,425 50	Refuse Industrial Landfill

5.0 WASTE CHARACTERIZATION

5.1 Selection of Plants for Sampling

Representative dry cleaners were visited to observe the usage of perchloroethylene and/or petroleum solvent, and to determine solvent quantities, operating characteristics, disposal practices, and to obtain samples of wastes generated. A total of 14 plants were initially selected to be sampled. The focus of sampling was primarily on hot and transfer technology using perchloroethylene, which predominate in the industry, with sufficient plants using other technologies to be representative, as indicated below:

- o Hot and transfer processing with perchloroethylene - 11 plants were sampled with a fairly equal distribution between hot and transfer; and small, medium and large plants;
- o Transfer processing with petroleum solvent - 3 plants
- o Refrigerated processing with perchloroethylene - 3 plants

Three of the plants sampled used two or all three of the different types of processing technology available.

Plants were also selected to cover the different forms of solvent conditioning/recovery (stills, cartridge filters and diatomaceous earth filters), as well as the different types of methods used for solvent recovery from cartridges.

In addition to the 14 plants sampled initially, 2 extra dry cleaners, both large, hot, perchloroethylene plants, were included in the sampling program at a later date. One of these additional plants dry cleans strictly industrial wear (mainly gloves), and only operates distillation units, with no filtration. The other plant, which operates a sparging unit for the steam-stripping of filter cartridges, was chosen to run a stripping test at exact manufacturer's operating specifications, to determine the maximum amount of solvent that could be removed via the process.

Table 5.1 lists the 16 plants sampled, indicating the type of technology used in the operations of dry cleaning and solvent conditioning/recovery, as well as the plant size and quantity of dry cleaning processed.

5.2 Sampling and Analytical Protocols

5.2.1 Sampling

Upon collection, waste samples from dry cleaning establishments were returned to the laboratory and weighed immediately. Prior to analysis, samples were weighed again to determine if any losses had occurred during storage. Although in most cases there was a lag time of a couple of weeks between collection and analysis, no losses of solvent were apparent.

Samples were taken of still bottom sludges, filter muck and spent cartridges where available. In some cases, only still bottom sludges were available for sampling, since the filter cartridges were still being used and were not scheduled to be changed for some time. When possible, sampling was scheduled around the removal of cartridges, since this was a relatively infrequent occurrence. Distillation and filtration through a diatomaceous earth filter are conducted on a much more frequent basis, and samples of these wastes were therefore readily available at any time.

Samples were collected in glass bottles, sealed with tape, and refrigerated until extraction. Still bottom sludges and cooked filter muck were placed directly in the sample containers at the sampling location. Cartridge filters, however, were returned to the laboratory, and the total cartridge weight was determined prior to the disassembly of the filter to obtain separate samples of the paper and the absorbent material.

Fresh samples of still bottom sludges and filter muck were taken where possible, instead of taking samples from drums which may have been sitting for awhile, with probable losses of solvent. Sludges were first well-mixed to obtain representative samples.

A second sample of sludge was taken at one plant approximately 3 weeks after the first sampling date. This was to allow for an estimate of in-plant variability. Thus both plant-to-plant variations and in-plant variations were determined.

TABLE 5.1 SUMMARY OF OPERATING CHARACTERISTICS FOR DRY CLEANING PLANTS SAMPLED

Plant Code	Processing Technology	Solvent Type	Plant Size	Annual Dry Cleaning Processed (kg/yr)	Annual Solvent Purchases (L/yr)	Solvent Mileage (L/1,000 kg)	SOLVENT CONDITIONING TECHNOLOGY				SOLVENT RECOVERY		
							Distillation Units	Diatomaceous Earth Filters	Cartridge Type*	Solvent Reclaim Tumblers	Carbon Adsorber	Recovery from Cartridges**	
1	Refrigerated	Perc	S	21,800	460	21	1	0	JCC	0	0	NR	
2	Hot	Perc	S	15,000	460	31	1	0	SCC, SAC	0	0	D (24 hours)	
3	Hot Transfer	Perc	S	21,800	1,400	64	0	1	0	0	0	-	
		P.S.	S	10,900	415	1	1	0	0	0	-		
4	Transfer Hot	Perc	S	19,600	200	35	1	0	JCC	1	1	C/S (3 weeks)	
		Perc	S	10,300	200	22	1	0	JAd	0	-	C/S (1 week)	
5	Refrigerated	Perc	M	87,100	500	6	0	1	0	0	0	-	
6	Transfer	Perc	M	59,400	5,300	100	1	0	SCC, SAC	2	1	SS	
7	Transfer	Perc	M	58,500	3,800	64	2	0	SPP, SCC, SAC	2	2	SS (2 days)	
8	Hot	Perc	M	53,300	900	17	3	0	SCC, SAC	0	0	SS (8 hours)	
9	Transfer	Perc	L	130,600	5,500	42	1	0	JCC, JAC	1	1	C/S (1 week)	
10	Hot	Perc	L	163,300	2,700	17	1	0	SCC	0	0	D (1 day)	
11	Transfer	P.S.	L	131,000	43,100	331	0	0	JCC, JAC, JAd	0	0	NR	
12	Refrigerated Hot Transfer	Perc	M	51,200	1,600	31	1	0	SCC, JAd	0	0	1 (4 hours)	
		Perc	L	108,900	92	92	1	0	0	2	0	-	
		P.S.	S	19,600	3,400	172	0	0	JAd	0	0	NR	
13	Hot	Perc	L	185,000	3,200	17	1	0	SCC	0	1	C/S (1 week)	
14	Transfer	Perc	L	130,600	5,400	41	0	1	0	1	1	-	
15	Hot	Perc	L	832,000	23,300	28	4	0	0	2	2	-	
16	Hot	Perc	L	436,000	14,500	33	5	0	SCC	2	2	SS (8 hours)	

Plant Size: S - small plant (less than 36,000 kg of dry cleaning processed a year)
M - medium plant (36,000 kg to 90,000 kg of dry cleaning processed a year)
L - large plant (more than 90,000 kg of dry cleaning processed a year)

1 Perc - Perchloromethylene; P.S. - Petroleum Solvent
Cartridge Types: S - Standard; CC - Carbon Core; PP - Plain Paper; J - Jumbo AC - All Carbons; Ad - Adsorbent (Clay and carbon)
** Solvent Recovery from Cartridges: NR - No Recovery; D - Drang T - Tumbler Dry; C/S - Cabinet Solvent; SS - Steam Strip.

5.2.2 Analytical Protocols

5.2.2.1 Sorbent (Charcoal and Clay)

Perchloroethylene and Petroleum Solvent

A small portion (50 mg) of the total sample collected from each cartridge was placed in a small septum cap vial with carbon disulphide for extraction and subsequent analysis. After extraction in the vial, the extract was analyzed by GC equipped with an FID detector. Specific analytical conditions are presented in Appendix 3. The method as used, was an adaptation of a method obtained from the International Fabricare Institute (IFI) (see also Appendix 3).

5.2.2.2 Filter Papers

Perchloroethylene and Petroleum Solvent

The method for the extraction and analysis of perchloroethylene and petroleum solvent in cartridge papers was also adapted from a method obtained from IFI. A representative portion of filter paper was extracted for 4 hours in a standard Soxhlet extractor with dichloromethane. Analysis of the extract was by GC equipped with an FID detector. Details of the method are presented in Appendix 3.

5.3 Cartridge Composition

Tables 5.2 and 5.3 list the solvent content on a percent basis and weight basis, respectively, found in filter cartridges obtained from the plants sampled.

The values in Table 5.2 for the percentage of solvent in the carbon and the paper were obtained directly by analysis. The figure for the overall percentage of perchloroethylene in the filter (weight of solvent per the total weight of the cartridge) was calculated by determining the percentage by weight of each filter component (i.e., paper and carbon/clay), and multiplying this figure by the percentage of solvent found in that compartment.

TABLE 5.2

SOLVENT CONTENT OF CARTRIDGES FOR
DRY CLEANING PLANTS SAMPLED (% basis)

Processing Technology	Recovery Technology	CARTRIDGE TYPE (% wt/wt)										
		STANDARD					JUMBO					
		Carbon Core			Plain Paper		Carbon Core			Adsorptive		
		Carbon ¹	Paper ²	Total ³	Paper	Total	Carbon	Paper	Total	Car/Clay	Paper	Total
<u>Perchloroethylene</u>												
Transfer:	Small	-	-	-	-	-	10.0	0.74	6.6	13.0	0.73	8.5
	Medium	16.0	1.0	5.14	-	-	-	-	-	-	-	-
	Medium	-	-	-	0.33	0.27	-	-	-	-	-	-
	Large	-	-	-	-	-	42.0	1.3	27.4	-	-	-
Hot:	Large	47.0	1.0*	16.89	-	-	-	-	-	-	-	-
	Large	25.0	0.25	7.38	-	-	-	-	-	-	-	-
	Large	4.0	0.0065	1.16	-	-	-	-	-	-	-	-
<u>Petroleum Solvent</u>												
Transfer:	Small	-	-	-	-	-	-	-	-	61.4	31.0	29.7
	Large	-	-	-	-	-	-	-	-	17.7	30.0	13.2

¹ Weight of solvent/weight of carbon.² Weight of solvent/weight of paper.³ Weight of solvent/total weight of cartridge.

* Solvent content in paper assumed as 1%.

TABLE 5.3 SOLVENT CONTENT (KG) OF CARTRIDGES FOR DRY CLEANING PLANTS SAMPLED

Processing Technology			Recovery Technology	CARTRIDGE TYPE			
				Standard		Jumbo	
				Carbon Core	Plain Paper	Carbon Core	Adsorptive
<u>Perchloroethylene:</u>							
Transfer	- Small	Cab/Sniffer 3 weeks	-	-	1.4 (21.0)	2.2 (25.7)	
	- Medium	Steam Strip	0.25 (4.8)*	-	-	-	
	- Medium	Steam Strip 2 days	-	0.01 (3.6)	-	-	
	- Large	Cab/Sniffer 1 week	-	-	7.1 (25.9)	-	
Hot	- Large	Overnight Drain	0.93 (5.5)	-	-	-	
	- Large	Cab/Sniffer 1 week	0.36 (4.9)	-	-	-	
	- Large	Steam Strip 8 hours	0.06 (5.0)	-	-	-	
<u>Petroleum Solvent:</u>							
Transfer	- Small	No Recovery	-	-	-	8.2 (27.5)	
	- Large	No Recovery	-	-	-	3.1 (23.4)	

* - Value In Brackets Represents The Weight Of The Total Cartridge On Disposal

The values for the mass of solvent found in each cartridge (Table 5.3) were calculated by taking the figure for the overall percentage of solvent in the cartridge and multiplying this number by the disposal weight of the cartridge.

5.3.1 Perchloroethylene

Based on the results indicated in these tables, steam stripping, conducted following the exact manufacturers specifications on operation, leads to the lowest concentration of perchloroethylene in the carbon, and hence the overall filter. The overall concentration of perchloroethylene in the standard size carbon core cartridge filter which was steam stripped was 1.16%. Another carbon-core cartridge which was also steam-stripped, however, contained a higher concentration of perchloroethylene, 5.14%. The exact length of time and operating procedure (e.g., value of steam pressure system run at) for this cartridge was unknown. Consequently a direct comparison to results obtained from the cartridge steam-stripped at manufacturers specification is not possible.

The standard carbon-core cartridge which was placed in a cabinet/sniffer arrangement contained overall perchloroethylene levels of 7.38%, which is halfway between those obtained from a steam-stripped cartridge and a cartridge which was drained overnight (16.9%). The standard plain paper cartridge contained very little perchloroethylene, only 0.27%, since perchloroethylene is removed fairly easily from paper. In most cases, the perchloroethylene content of the paper, for both jumbo and standard size cartridges, was less than 1%.

The two jumbo cartridges, which had been in a cabinet/sniffer for 3 weeks, were analyzed to contain 10% (for the Jumbo Carbon Core) and 13% (for the Jumbo Adsorptive) perchloroethylene in the absorbent layer, giving an overall value of 6.6% and 8.5%, respectively. However, another jumbo carbon-core cartridge which was also stripped in a cabinet/sniffer but only for 1 week, had 42% solvent in the carbon. This is only slightly less than the 47% contained in the carbon of the filter which was just drained overnight. The cartridge containing 42% perc in the carbon was used for 700 kg of processing, while the one containing 10% perc was only used for 50 kg of dry cleaning. This meant that a substantially larger volume of solvent was filtered through the first cartridge, providing a greater opportunity for the perchloroethylene content to build up in the carbon.

Another standard cartridge, which was also in a cabinet/sniffer for one week, had a value of 25% perchloroethylene in the carbon. This indicates how variable results may be, depending on how the operation is run, with no real correlation between processing technology and efficiency of recovery of solvent from the cartridge. Maximum recovery is more dependent on how well a system is run as specified by manufacturers, rather than on the size of the plant or type of processing used.

One dry cleaner submitted his cartridge to be analyzed independent of the sampling program conducted by BEAK. The results of this analysis are not included in Tables 5.2 and 5.3. This standard carbon-core cartridge had been sitting in a cabinet/sniffer for 2 to 3 months. The operator allowed the spent cartridges to remain in the cabinet until the next set of cartridges were changed and required recovery. From the analytical testing, it was determined that 5.2% perchloroethylene was present in the carbon. Assuming a level of 1% perchloroethylene in the paper, the overall amount of perchloroethylene in the cartridge would be 2.0%. As the level of perchloroethylene in the paper will likely be much less than 1.0%, this brings the overall amount to slightly less than 2.0%, which would be only slightly more than values found in steam-stripped cartridges run at manufacturers specifications.

The International Fabricare Institute (IFI) recently conducted a study to determine how much perchloroethylene could be removed from spent cartridges by several of the methods mentioned earlier (IFI, 1986). These results are presented in Table 5.4. The recovery methods used were either recommended by the manufacturer/distributor of the equipment or were conceived by the plant owner. Since dry cleaners had complete control over the amount of time the cartridge was processed, the results shown may be lower or higher than those achieved "on average".

The methods examined to recover perchloroethylene included placing the cartridge in the dry cleaning wheel, lint trap, or still, as well as cooking the cartridge in its original filter tube. Again, a large variability in results can be seen. The lowest overall value measured was 2.11% for a cartridge steam stripped in a still with steam sweep. The suppliers and manufacturers of these systems claim that steam-stripping can reduce the overall perchloroethylene level to only 0.2% on a weight basis, with 0.4% of the perchloroethylene in the carbon and 0.02% in the paper, based on tests run on "clean" cartridges which had been soaked in solvent. These claims have not been substantiated

TABLE 5.4 VALUES REPORTED FOR PERCHLOROETHYLENE
IN CARTRIDGES TREATED BY DIFFERENT METHODS

Method	Time Spent	Cartridge Type	Avg. % of Perc in Carbon (wt/wt)	Avg. % of Perc in Paper (wt/wt)	Total Avg. % in Cartridges (wt/wt)
<u>Dry Heat</u>					
Drying in Housing	24 hrs	Standard	9.95	0.079	2.90
Drying in Lint Trap	1 wk	Standard	16.31	0.350	4.91
Drying in Dry Cleaning Units	4.5 hrs	Standard	42.33	32.31	35.17
Drying in Distillation Unit	8 hrs	Standard	51.94	6.75	19.66
<u>Live Steam</u>					
Cooked in Housing	5 hrs	Adsorptive	3.86	0.007	3.55
Still with Steam Sweep	5 hrs	Adsorptive	2.29	0.089	2.11
Still with Steam Injection System	6 hrs	Standard	15.88	0.815	5.11

Source: International Fabricare Institute (1986)

by results from this study, or others such as the one conducted by the IFI. A 0.2% level of perchloroethylene in the total cartridge appears to be unattainable in actual situations, but may be possible in controlled laboratory conditions.

5.3.2 Petroleum Solvent

The only type of cartridge samples obtained from petroleum solvent plants were 2 jumbo adsorptive cartridges on which no recovery of solvent had been practiced. In both cases, the amount of solvent in the paper was in the range of 30%. However, the amount in the inner adsorptive layer differed greatly from 41% in one filter, to 18% in the other. This may be due in part to the fact that the cartridge with more solvent in the carbon/clay layer was used for more than twice as much processing - 950 kg of dry cleaning/cartridge versus 450 kg of dry cleaning/cartridge.

5.3.3 Summary

All of the methods mentioned to recover solvent from cartridges provide an economic advantage to the dry cleaner, as his solvent usage is decreased with better recovery. The cartridges are also lighter and less objectionable to handle after some form of recovery has been practiced. However, it appears that about 1% perchloroethylene is the lowest concentration achievable by any of the presently used methods that remove perchloroethylene from cartridges, based on the results presented in Table 5.2 and Table 5.4.

5.4 Sludge and Filter Muck Composition

Table 5.5 presents the solvent content of still bottom sludges and cooked filter muck from the dry cleaning plants sampled.

As was apparent with filter cartridges, there can be a large variability in the values of perchloroethylene found in sludges and filter muck. Still bottom sludges were found to contain anywhere from 0.26% up to 75% perchloroethylene, while values in the filter muck ranged from 2.1% up to 56.0% perchloroethylene.

TABLE 5.5 SOLVENT CONTENT OF STILL BOTTOM SLUDGES
AND FILTER MUCK FOR DRY CLEANING PLANTS SAMPLED

Processing Technology		Still Bottom Sludges (% by wt)		Filter Muck (% by wt)
		Average	Range	
<u>Perchloroethylene:</u>				
Transfer	- Small	23.0	-	-
	- Medium	10.4	0.8 - 34	-
	- Large	53.0	-	2.1
Hot	- Small	64.0	-	56.0
	- Medium	8.3	-	-
	- Large	26.3	0.68 - 75	-
Refrigerated	- Small	51.0	-	-
	- Medium	0.26		15.0
Overall Average (All Samples)		28.5		24.4

Petroleum Solvent:

Transfer	- Small	-	-	16.2
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There appears to be no correlation between processing technology and losses of perchloroethylene in sludges and filter muck. The distillation process is relatively unsophisticated in terms of process control, leading to large variations in the amount of solvent losses. Results vary from plant to plant due to reasons such as differences in residue constituents, operator attention, temperature of the heating coils, as well as the cleanliness of the heating coils.

The average value of perchloroethylene in still bottom sludges and filter muck was determined to be 28.5% and 24.4% respectively. These values are similar to those obtained by the Waste Management Branch in Alberta, which found concentrations ranging from less than 1% to 68% perchloroethylene, with average values around 30% for both still bottoms and filter muck.

No still bottom sludges were available for analysis from petroleum solvent plants. A filter muck sample, however, was found to contain 16.2% by weight petroleum solvent.

IFI recently introduced a method to its members whereby the perchloroethylene content could be reduced substantially in residues, to as low as 1.0% in sludges and filter muck. This procedure is termed the "water addition" method. After the initial cooking/boil-down, water is added to still residues and cooker muck and regular distillation is continued. This procedure is followed twice for still bottom sludges and once for filter muck. In one case, one cleaner had 69.2% perchloroethylene content in the sludge after the conventional boil-down. The first water addition reduced the solvent content to 15.7%, while the second addition decreased the perchloroethylene content to 1.5%. Many of the dry cleaners in the United States who have tried this method were enthusiastic about the results.

The majority of the dry cleaners in Ontario are unaware of this process, and none of the plants surveyed were found to use this method. However, this process modification appears to be unnecessary in Ontario given the high percentage of plants sending their still bottoms to recyclers. In addition, the water addition method could potentially lead to solvent quality problems (such as odours in cleaned garments) and additional technical difficulties in operation.

5.5 Summary of Waste Characteristics for Plants Sampled

Table 5.7 summarizes the characteristics of wastes generated by the plants sampled, listing the total quantity of wastes disposed of, the solvent content in each waste type, and the total solvent losses due to waste disposal.

For samples analyzed, solvent losses via waste disposal were calculated directly by taking the solvent content of the sludge or filter muck and multiplying this value by the quantity of residue disposed of. A value of 30% solvent in the still bottom sludges was assumed for plant 3, a petroleum solvent dry cleaning facility, since no testing was done on sludge from petroleum solvent plants.

The figures for solvent losses in spent cartridges were determined by using the values in Table 5.6 for the quantity of solvent per individual cartridge type, and multiplying this value by the total number of cartridges disposed of. The numbers in Table 5.6 were developed from the values given earlier in Table 5.3 for cartridges from dry cleaning plants which were sampled and analyzed. In cases where there was no analysis done on a particular cartridge type, estimated values were used. These estimates were calculated using the average analyzed values of solvent found in the carbon and paper layers of the cartridges sampled, and extrapolating these values to a particular type of cartridge. For example, no analyses were conducted on a standard all carbon cartridge (SAC), but results were obtained for a standard carbon core cartridge (SCC). Therefore, the values for the solvent content in the carbon layer of the SCC, were used and extended to the case of a SAC filter, where the cartridge is only carbon with no paper layer present.

Several assumptions were made in determining the expected average content per cartridge type. The content of perchloroethylene in the paper layer was assumed to be 1%, even though the average measured through the analytical testing was 0.6%. The solvent content in the paper is not a critical amount and 1% was chosen to be slightly conservative. The content of perchloroethylene in the carbon was calculated to average 24% in the analyzed cartridges.

One adsorptive type cartridge containing an inner annulus of carbon/clay was obtained from a perchloroethylene plant. This cartridge, which had been placed in a cabinet/sniffer for 3 weeks, contained 13% solvent in the inner core. Since no other cartridges of

TABLE 5.6

ESTIMATED VALUES OF SOLVENT
LOSSES BY FILTER CARTRIDGE TYPE

Cartridge Type	Kg of Solvent/Cartridge	
	Perchloroethylene	Petroleum Solvent
Standard - Carbon Core	0.4	1.17*
	1.6*	2.1*
	0.03	0.9*
Jumbo - Carbon Core	3.5	5.0*
	4.8*	6.0*
	0.2*	4.0*
	3.5	5.0

*Values based on analysis of cartridge samples.

TABLE 5.7

WASTE CHARACTERISTICS FROM DRY CLEANING PLANTS SAMPLED

Plant Code	Processing Technology	Solvent Type	Plant Size	Waste Solvent Content (%)				Waste Quantities				Solvent Losses (kg/yr) by Wastes				Total Solvent Losses kg/yr	% of solvent purchased
				Annual Dry-Cleaning Processed (kg/yr)	Annual Solvent Purchases (l/yr)	Still Bottom Sludges	Filter Sludge	Cart. Sludge (kg/yr)	Filter Sludge (kg/yr)	Filter Cart. No./yr	Sludges	Filter Muck	Cartridges	Sludges	Filter Muck		
1	Refrigerated	Perc	S	21,800	460	51.0	-	-	152	-	48(SCC)	78	-	168	-	206	33.0
2	Hot	Perc	S	15,000	460	64.0	-	-	102	-	8(SCC)	65	-	32	-	75	10.1
3	Hot Transfer	P.S.	S	21,800	1400	-	56.0	-	-	159	-	89	-	-	-	89	4.0
4	Transfer	Perc	S	19,600	200	23.0	16.2	-	508	113	-	18	-	-	-	170	5.0
5	Hot Transfer	Perc	S	10,300	200	-	-	6.6	305	-	30(SCC)	70	-	42	-	178	11.9
6	Refrigerated	Perc	M	87,100	500	-	15.0	-	-	425	-	69	-	-	-	69	7.1
7	Transfer	Perc	M	59,400	5800	36.0	-	5.16	813	-	28(SCC)	276	-	20	-	336	3.7
8	Hot	Perc	M	53,300	900	5.6	-	0.27	1209	-	24(SCC)	68	-	38	-	115	1.9
9	Transfer	Perc	L	130,600	5900	8.3	-	-	508	-	78(SCC)	-	-	1	-	119	7.6
10	Hot	Perc	L	163,300	2700	53.0	27.4	-	1524	-	90(SCC)	808	-	639	-	1879	21.0
11	Transfer	P.S.	L	131,000	4100	75.0	16.89	1016	-	90(SCC)	912	-	-	75	-	837	18.7
12	Refrigerated	Perc	M	51,200	1600	-	13.2	-	-	20(SCC)	-	-	-	1000	-	1228	3.8
13	Hot Transfer	P.S.	L	108,900	10,000	0.26	-	-	1524	-	24(SCC)	-	-	150	-	78	0.5
14	Hot	Perc	S	19,600	3000	0.68	-	36.80	-	19(SCC)	4	-	-	32	-	103	0.5
15	Hot	Perc	L	185,000	3200	49.0	29.7	-	36.80	-	90(SCC)	23	-	328	-	328	13.0
16	Transfer	Perc	L	130,600	5900	-	7.38	1829	-	60(SCC)	896	-	-	216	-	1112	21.2
17	Hot	Perc	L	832,000	23,500	5.4	2.1	-	735	-	-	15	-	-	-	15	0.2
18	Hot	Perc	L	436,600	14,500	1.8	1.16	-	69,949	-	3707	-	-	-	-	3707	9.6
19	Hot	Perc	L	436,600	14,500	1.8	1.16	-	69,949	-	80	-	-	35	-	115	0.5

Plant Size:

S

M

L

Small Plant (less than 46,000 kg of dry-cleaning processed per year)

Medium Plant (46,000 kg to 90,000 kg of dry-cleaning processed per year)

Large Plant (more than 90,000 kg of dry-cleaning processed per year)

* Assume solvent content of 10%.

** Assume solvent content in paper 10%.

SCC Standard carbon core
TAC Standard carbon
IAC Standard carbon
SPP Standard plain paper

this type were available, a more representative figure on the average perchloroethylene content could not be obtained. However, the same perchloroethylene plant also had a jumbo carbon-core cartridge analyzed, which was found to contain 10% perchloroethylene in the carbon layer. Since both cartridges followed the same processing, it appears likely that the average values of solvent found in carbon/clay would be in the same range as those found in carbon. A value of 13% perchloroethylene was thus chosen as the average solvent content in the carbon/clay layer, the same as found in a carbon layer.

The percentage of solvent for each cartridge type was then calculated using the estimated values for solvent content in the paper and the adsorbent layer. The total amount of solvent per cartridge (in kilograms) was then calculated by taking the average disposal weight of the cartridge and multiplying this number by the percentage of perchloroethylene in the whole cartridge. Disposal weights of cartridges were obtained by direct measurement in the laboratory, as well as through conversations with individual dry cleaners.

Solvent content in cartridges from petroleum solvent plants was calculated in the same way. However, the solvent content will be higher since no recovery of solvent is usually practiced. The content of petroleum solvent in the paper was assumed to be 30%, while the content in the carbon and carbon/clay core was taken as 29%, the average of the two cartridges sampled.

The last column in the table calculates the percentage of solvent used annually which is disposed of with wastes generated in the dry cleaning process. The average for perchloroethylene losses in wastes was 10.1%, although values ranged from as low as 0.2% up to a high of 33.0%. Petroleum solvent plants showed a slightly lower loss at 7.3%, with a range of 3.8 to 13.0%. Considering that recovery is not practiced by petroleum solvent plants, the lower percent loss suggests that other losses (e.g., to atmosphere or to sewers) must be higher in petroleum solvent plants than in perchloroethylene plants.

6.0 WASTE GENERATION

6.1 Extrapolation Methodology

Estimates of the quantity and solvent content of wastes generated by the total dry cleaning industry in Ontario were obtained by an extrapolation of the results compiled from the 158 plants surveyed. The distribution by technology and plant size was also determined using the data calculated in Chapter 4.0, and observations made by the DCLI.

The method of estimation used was as follows:

- (1) Assume 10% of all dry cleaning plants use either petroleum solvent or fluorocarbons, while 90% use perchloroethylene. On this basis, about 1185 out of the 1316 dry cleaning establishments would use perchloroethylene as the cleaning solvent.
- (2) Assume a size distribution of 80% small plants (as per DCLI), with approximately 40 large plants. From the survey, 3 large petroleum solvent plants and 33 large perchloroethylene plants were surveyed. Using this information, the following size distribution by solvent was obtained.

Perchloroethylene:	Small	-	950	plants
	Medium	-	199	plants
	Large	-	36	plants
			<hr/>	
			1185	plants

Petroleum Solvent:	Small	-	105	plants
	Medium	-	22	plants
	Large	-	4	plants
			<hr/>	
			131	plants

- (3) Using the data given in Table 4.5, which presents the distribution by processing technology and size for the dry cleaning plants surveyed, a breakdown between transfer, hot and refrigerated plants was estimated as shown below.

Small Plants:	Transfer	- 60%
	Hot	- 37%
	Refrigerated	- 3%
Medium Plants:	Transfer	- 55%
	Hot	- 28%
	Refrigerated	- 17%
Large Plants:	Transfer	- 47%
	Hot	- 50%
	Refrigerated	- 3%

These three steps determined the estimated number of plants by solvent use, size and processing technology. This data is summarized in Table 6.1 and forms the basis for all other extrapolations to determine waste quantities generated.

Estimates of total waste quantities were determined by taking the average quantity of residues generated per plant by technology and plant size, and multiplying this value by the number of plants in that category. Solvent losses were obtained by taking the mean solvent concentration in residues, as determined by analysis, and multiplying by the quantity of wastes. A further breakdown into the estimated quantities generated by the six different MOE regions was accomplished using the regional plant distribution developed in Section 4.1 and the technology and size distribution given in Table 6.1.

6.2 Quantities by Technology and Plant Size

Using the extrapolation methodology outlined, estimates were made of the quantity of wastes generated by each category of plant size and processing technology, as well as corresponding solvent losses expected in each waste type.

TABLE 6.1

 PROVINCE-WIDE DISTRIBUTION
 BY SIZE AND SOLVENT USE

Solvent	Total Number of Plants	Size Distribution					
		<u>Small</u>		<u>Medium</u>		<u>Large</u>	
		#	%	#	%	#	%
Perchloroethylene							
Transfer	697	570	60	110	55	17	47
Hot	426	352	37	56	23	18	50
Refrigerated	62	28	3	33	17	1	3
Sub-Total:	1185	950	100	199	100	36	100
Petroleum Solvent	131	105	80	22	17	4	3
Total	1316	1055		221		40	

Table 6.2 through 6.4 present the estimated quantities of still bottom sludge, filter muck, and spent filter cartridges generated by the dry cleaning industry province-wide. The first portion of the tables repeats the data formulated from the plants surveyed. The number of plants per each category and the percentage of plants in each section using the distillation process, and the diatomaceous earth filter or cartridge filter is documented. The quantity of solvent estimated to be lost in the waste residues, in terms of kilograms per plant per year, was calculated by taking the total quantity of waste generated by the dry cleaners surveyed, multiplying this by the average solvent content of the waste as determined analytically, and dividing by the number of plants which generated the wastes. This produces an average value for each size category and major process category, which is then multiplied by the total number of plants in the province to give the overall quantity of waste solvent losses.

Table 6.2 examines the waste solvent residues in still bottom sludges province-wide. The total quantity of solvent disposed of in sludges from perchloroethylene plants was calculated to be 181,900 kg/year. Of the 130 plants surveyed which reported the use of distillation units, only 109 provided data on the quantity of still bottom sludges produced. Consequently, the number of plants reported in Table 6.2 (109), is lower than that shown in Table 4.8 (130).

The largest quantity of solvent losses in sludges appears to be from medium-sized plants using the transfer processing technology, which generated about 58,000 kg of perchloroethylene in their waste sludges. The second highest losses occurred from the 18 large, hot plants, which produced 36,000 kg of waste solvent. A large proportion of this 36,000 kg of solvent losses was produced by 2 to 3 very large plants which generated substantially more sludge than some of the other large, hot dry cleaning establishments. However, as noted by the DCUI, solvent losses on a tonnage basis (ie, slovent losses per kg of dry cleaning processed) should be consistent for different technologies.

The next highest producer of waste solvent volumes was the category of small, hot dry cleaning plants, which disposed of almost 29,000 kg of solvent in their waste sludges. Although the number of plants included in this category is much larger than the number of large hot, plants (239 vs 18), the total quantity of waste solvent disposed of was less due to the lower mean value of losses per plant, 2000 kg/plant/yr for large, hot plants versus 100 kg/plant/yr for small, hot plants.

TABLE 6.2

ESTIMATED WASTE SOLVENT RESIDUES IN STILL BOTTOM SLUDGES
FOR THE TOTAL ONTARIO DRY CLEANING INDUSTRY

SIZE	PROCESS	SURVEY RESULTS*			PROVINCE-WIDE		
		No. of Plants	Quantity of Sludge (kg/yr)	Quantity of Solvent in Sludge*** (kg/plant·yr)	Totals of Plants	No. of Plants Using Stills**	Solvent Losses in Sludge (kg/yr)
<u>Perchloroethylene</u>							
Small	Transfer	12	2,500	715	570	399	23,900
	Hot	15	5,300	1,510	352	289	28,900
	Refrigerated	3	1,000	285	28	21	2,000
Medium	Transfer	33	62,700	17,870	110	107	58,000
	Hot	7	9,000	2,565	56	56	20,500
	Refrigerated	10	5,200	1,480	33	27	4,000
Large	Transfer	14	23,600	6,725	17	16	7,700
	Hot	14	98,200	27,985	18	18	36,000
	Refrigerated	1	3,100	885	1	1	900
TOTALS		109	88		1,185	934	181,900
<u>Petroleum Solvent</u>							
Small	Transfer	5	2,900	870	105	53	9,300
	Medium	2	400	120	22	6	400
	Large	2	66,300	19,890	4	3	29,800
TOTALS					131	62	39,500

* Based on Table 4.6 and Table 4.10.

** Number of Plants Using Stills (Total No. of Plants) x % (from Survey Results).

*** Average solvent content in sludges:
perchloroethylene 28.5%
petroleum solvent 30%

TABLE 6.3

ESTIMATED WASTE SOLVENT RESIDUES IN FILTER MUCK
FOR THE TOTAL ONTARIO DRY CLEANING INDUSTRY

SIZE	PROCESS	SURVEY RESULTS*				PROVINCE-WIDE		
		No. of Plants	Quantity of Filter Muck (kg/yr)	Quantity of Solvent in Muck (kg/yr) [†]	(kg/plant·yr)	Totals of Plants	No. of Plants Using D.E. Filters**	Solvent Losses in Filter Muck (kg/yr)
<u>Perchloroethylene</u>								
Small	Transfer	3	700	170	55	570	51	2,800
	Hot	1	200	50	50	352	18	900
	Refrigerated	-	-	-	-	28	-	-
Medium	Transfer	1	100	25	25	110	3	100
	Hot	2	5,000	1,220	610	56	6	3,700
	Refrigerated	2	1,000	245	120	33	6	700
Large	Transfer	5	11,800	2,880	575	17	6	3,500
	Hot	2	5,300	1,295	650	18	2	1,300
	Refrigerated	-	-	-	-	1	-	-
TOTALS						1,185	92	13,000
<u>Petroleum Solvent</u>								
Small	Transfer	3	900	145	50	105	32	1,600
	Medium	1	100	15	15	22	6	100
	Large	1	90,700	14,700	14,700	4	1	14,700
TOTALS						131	39	16,400

* Based on Table 4.6 and Table 4.10.

** Number of Plants Using D.E. = Total No. of Plants x % (from Survey Results).

† Average solvent content: perchloroethylene = 24.4%
petroleum solvent = 16.2%

TABLE 6.4

ESTIMATED WASTE SOLVENT RESIDUES IN FILTER CARTRIDGES FOR THE TOTAL ONTARIO DRY CLEANING INDUSTRY

Size	Process	# of Plants Surveyed	SURVEY RESULTS										PROVINCE WIDE		
			%	Solvent Content in Cartridges (kg./plant-yr)*				JAC	JAD	Total	Total # of Plants	# of Plants Using Cart.	Quantity of Solvent in Cart. (kg/yr)		
				SCC	SAC	SPP	JCC								
<u>Percchloroethylene</u>															
Small	Transfer	28	91	14	3	0.1	9	11	-	22	59.1	570	519	30,600	
	Hot	17	86	14	8	0.2	4	3	0.2	12	41.4	352	303	12,400	
	Refrigerated	2	100	41	16	-	84	-	-	-	191	28	28	3,900	
Medium	Transfer	32	97	6	44	0.2	316	25	0.2	-	391.4	110	107	41,800	
	Hot	15	83	19	4	-	5	4	-	26	58	56	47	2,700	
	Refrigerated	8	73	20	9	0.3	-	-	-	29	58.3	33	24	1,600	
Large	Transfer	10	67	91	12	-	31	43	-	146	323	17	11	3,600	
	Hot	16	84	49	20	-	145	-	-	-	214	18	16	3,400	
	Refrigerated	1	100	-	52	-	157	-	-	-	209	1	1	200	
															100,000
<u>Petroleum Solvent</u>															
Small	Transfer	8	80	26	7	-	2	15	-	41	91	105	84	7,600	
	Medium	4	100	37	11	-	125	-	-	185	158	22	22	7,900	
	Large	3	100	-	700	300	393	50	189	42	1674	4	4	6,700	
													22,200		

* Solvent content = solvent content/cartridge type (Table 5.6) x no. of cartridges disposed of per year (Table 5.7) divided by no. of plants (Table 5.7).
 ** Overall Solvent Losses = total solvent content per plant x no. of plants using cartridges

SCC = Standard Carbon Core
 SAC = Standard All-Carbon
 SPP = Standard Plam Paper

JCC = Jumbo Carbon Core
 JAC = Jumbo All-Carbon
 JPP = Jumbo Plam Paper
 JAD = Jumbo Adsorptive

Petroleum solvent plants generated 39,500 kg of solvent losses in their waste sludges, which is substantially less than the quantity generated by perchloroethylene plants. This is due not only to the fact that a smaller number of plants use this particular solvent, but also because a smaller percentage of petroleum-solvent plants use distillation units. The largest volume of waste solvent losses was produced by the large petroleum-solvent plants, which disposed of 75% of the total.

Solvent losses through the disposal of cooked filter muck from diatomaceous earth filtration are given in Table 6.3. In this case, losses are greater from the petroleum solvent plants than from plants using perchloroethylene: 16,400 kg of petroleum solvent losses versus 13,000 kg of perchloroethylene losses. Diatomaceous earth filtration is generally practiced in older establishments, while cartridge filters are used in newer plants. As many of the petroleum solvent plants are older than their counterpart perchloroethylene plants, they would use diatomaceous earth filtration. This may partially explain the difference in solvent quantities generated. Also, as mentioned in an earlier section, the total for wastes from petroleum solvent plants includes one very large plant which processes much more dry cleaning than the other large plants, leading to larger waste quantities. This one large petroleum solvent plant generated 14,700 kg of solvent/yr in their filter muck, while the most produced from large perchloroethylene plants was 650 kg of solvent per plant per year.

Table 6.4 presents the waste solvent residues found in filter cartridges for the total Ontario dry cleaning industry. Expected solvent losses is broken down into quantities by cartridge type.

The quantity of solvent losses via cartridges in plants using perchloroethylene is less than the quantity found in sludges, but more than 7 times the losses through cooked filter muck. This unregulated portion of solvent disposal thus represents a relatively substantial amount of perchloroethylene losses.

The largest portion of the 100,000 kg of perchloroethylene solvent disposed of yearly in cartridges comes from small and medium sized transfer facilities. The larger establishments contribute only about 7% of the total losses. As well, the majority of the solvent is disposed of with jumbo carbon-core type cartridges.

Petroleum solvent plants produce 22,200 kg of solvent in spent filter cartridges, which is less than quantities found in still bottom sludges but more than quantities found in cooked filter muck. The distribution of losses by size of plants is fairly equally distributed, with slightly more associated with medium-size dry cleaners. Losses of petroleum solvent occur mainly with jumbo adsorptive type cartridges.

Table 6.5 summarizes the estimated solvent losses per plant by processing technology and size as determined in Tables 6.2, 6.3 and 6.4. Table 6.6 presents a summary of the estimated total waste solvent residues province-wide for each type of waste generated. The total amount of perchloroethylene losses via waste disposal totals 294,900 kg/year, while 78,100 kg is disposed of yearly from plants using petroleum solvent.

6.3 Quantities by Geographic Region

The distribution of waste generation as developed in Section 6.2. can be further subdivided into volumes by MOE Region.

The first step to accomplish this task is to determine the distribution of dry cleaning plants by size for each geographic region. This is shown in Table 6.7. From the total number of plants by region (Table 4.1), 90% are assumed to use perchloroethylene, with the remaining 10% petroleum solvent plants. The size distribution was then established as per Table 6.1.

From this size distribution, the number of plants in each region using a particular type of processing technology can be estimated using the methodology outlined earlier in Section 6.1. The results by each region are given in Appendix 4, and are summarized in Tables 6.8 and 6.9 for perchloroethylene plants and petroleum solvent plants, respectively.

As expected, the majority of losses occur in Region 3, due to the large number of dry cleaning establishments in this area. Region 3 accounts for 62.4% of the perchloroethylene losses, and 58.5% of the petroleum solvent losses. Regions 4, 5 and 6 combined only contribute 13.0% and 5.1% of the total solvent losses of perchloroethylene and petroleum solvent, respectively.

TABLE 6.5

SUMMARY OF ESTIMATED SOLVENT LOSSES
PER PLANT BY PROCESSING TECHNOLOGY AND SIZE

SIZE	PROCESS	SOLVENT LOSSES		
		Still Bottom Sludges (kg/plant/yr)	Filter Muck (kg/plant/yr)	Cartridges (kg/plant/yr)
<u>Perchloroethylene</u>				
Small	Transfer	60	55	59
	Hot	100	50	41
	Refrigerated	95	-	141
Medium	Transfer	540	25	390
	Hot	365	610	58
	Refrigerated	150	120	58
Large	Transfer	480	575	323
	Hot	2,000	650	214
	Refrigerated	885	-	209
<u>Petroleum Solvent</u>				
Small	Transfer	175	50	91
Medium	Transfer	60	15	358
Large	Transfer	9,945	14,700	1,674

TABLE 6.6 SUMMARY OF ESTIMATED TOTAL WASTE SOLVENT
RESIDUES PROVINCE-WIDE BY
PROCESSING TECHNOLOGY AND SIZE

SIZE	PROCESS	SOLVENT LOSSES IN WASTES (kg/yr)			
		Sludge	Filter Muck	Cartridges	Total
<u>Perchloroethylene</u>					
Small	Transfer	23,900	2,800	30,600	57,300
	Hot	28,900	900	12,400	42,200
	Refrigerated	2,000	-	3,900	5,900
Medium	Transfer	58,000	100	41,800	99,900
	Hot	20,500	3,700	2,700	26,900
	Refrigerated	4,000	700	1,400	6,100
Large	Transfer	7,700	3,500	3,600	14,800
	Hot	36,000	1,300	3,400	40,700
	Refrigerated	<u>900</u>	<u>-</u>	<u>200</u>	<u>1,000</u>
TOTALS		181,900	13,000	100,000	294,900
<u>Petroleum Solvent</u>					
Small	Transfer	9,300	1,600	7,600	18,500
Medium	Transfer	400	100	7,900	8,400
Large	Transfer	<u>29,800</u>	<u>14,700</u>	<u>6,700</u>	<u>51,200</u>
TOTALS		39,500	16,400	22,200	78,100

TABLE 6.7

DISTRIBUTION OF DRY CLEANING PLANTS BY MOE REGION
FOR THE TOTAL PROVINCE

MOE Region	Total No. of Plants	PERCHLOROETHYLENE PLANTS				PETROLEUM SOLVENT PLANTS			
		Total No. of Plants	No. of Small	No. of Medium	No. of Large	Total No. of Plants	No. of Small	No. of Medium	No. of Large
1	156	141	113	24	4	15	12	2	1
2	156	141	113	20	8	15	12	2	1
3	845	760	608	135	17	85	68	15	2
4	102	92	74	11	7	10	8	2	0
5	39	35	29	6	0	4	3	1	0
6	18	16	13	3	0	2	2	0	0
TOTALS	1,316	1,185	950	199	36	131	105	22	4

TABLE 6.8

SUMMARY OF ESTIMATED WASTE GENERATION
BY MOE REGION - PERCHLOROETHYLENE PLANTS

MOE Region	No. of Plants	SOLVENT LOSSES IN WASTES			TOTAL	
		Sludge (kg/yr)	Filter Muck (kg/yr)	Cartridges (kg/yr)	(kg/yr)	(%)
1	141	20,900	1,700	11,500	34,100	11.6
2	141	24,800	1,600	11,900	38,300	13.0
3	760	111,500	8,000	64,700	184,200	62.4
4	92	18,500	1,500	7,800	27,800	9.4
5	35	4,200	100	2,700	7,000	2.4
6	<u>16</u>	<u>2,000</u>	<u>100</u>	<u>1,400</u>	<u>3,500</u>	<u>1.2</u>
TOTAL	1,185	181,900	13,000	100,000	294,900	100

TABLE 6.9

SUMMARY OF ESTIMATED WASTE GENERATION
BY MOE REGION - PETROLEUM SOLVENT PLANTS

MOE Region	No. of Plants	SOLVENT LOSSES IN WASTES			TOTAL	
		Sludge (kg/yr)	Filter Muck (kg/yr)	Cartridges (kg/yr)	(kg/yr)	(%)
1	15	10,600	200	3,300	14,100	18.2
2	15	10,600	200	3,300	14,100	18.2
3	85	16,700	15,700	13,600	45,700	58.5
4	10	1,000	100	1,300	2,400	3.1
5	4	400	100	500	1,000	1.3
6	<u>2</u>	<u>200</u>	<u>100</u>	<u>200</u>	<u>500</u>	<u>0.7</u>
TOTAL	131	39,500	16,400	22,200	78,100	100

6.4 Mass Balance Over Province

6.4.1 Disposal Method

There are basically only 3 methods dry cleaners use to dispose of their wastes which contain solvent. These include submitting the wastes for recycling, unlicensed disposal (i.e., into municipal refuse) licensed disposal into a secure industrial landfill site. Some dry cleaners are stockpiling their wastes until a suitable disposal practice is decided upon.

Table 6.10 and 6.11 examine the distribution of waste residues by disposal practice for plants using perchloroethylene and petroleum solvent, respectively. Appendix 5 gives a more detailed breakdown of disposal practices used for each waste type versus size and processing technology.

As seen in Table 6.10, almost 59% of all perchloroethylene disposed of in waste residues is recycled. Still bottom sludges are the only waste type disposed of in this manner. No petroleum solvent wastes are recycled.

The licensed disposal of wastes containing perchloroethylene into secure landfill sites accounts for only 2.4% of the total waste quantity. Less than 1% of this total is accounted for by filter cartridges. Petroleum solvent plants, on the other hand, dispose of about 68% of their wastes by licensed disposal, with the majority of this total consisting of still bottom sludges.

Almost 40% of perchloroethylene wastes are dumped into municipal garbage, with cartridge filters accounting for 86% of this total. Most spent cartridge filters are disposed of in this way, as is the case with cooked filter muck. Only a small portion of still bottom sludges are disposed of into municipal refuse.

Most cartridges from petroleum solvent plants are also disposed of into municipal refuse, accounting for 78% of the total 30% of petroleum solvent wastes disposed of in this manner. Only a small quantity of petroleum solvent sludges and filter muck are disposed of by unlicensed disposal.

TABLE 6.10

ESTIMATED DISTRIBUTION OF WASTE RESIDUES
BY DISPOSAL PRACTICE - PERCHLOROETHYLENE
(KG OF SOLVENT LOSSES/YEAR)

Disposal Practice	Waste Residue	PLANT SIZE			Total (kg/yr)	%
		Small (kg/yr)	Medium (kg/yr)	Large (kg/yr)		
Recycled	Still Bottom Sludges	48,100	81,000	44,600	173,700	58.9
Licensed Disposal	Filter Muck	-	-	4,800	4,800	1.6
	Cartridges	<u>1,400</u>	<u>100</u>	<u>700</u>	<u>2,200</u>	<u>0.8</u>
Sub Total		1,400	100	5,500	7,000	2.4
Unlicensed Disposal	Still Bottom Sludges	6,700	1,000	-	7,700	2.6
	Filter Muck	3,700	4,400	-	8,100	2.8
	Cartridges	<u>45,500</u>	<u>45,800</u>	<u>6,500</u>	<u>97,800</u>	<u>33.1</u>
	Sub Total	55,900	51,200	6,500	113,600	38.5
Stockpiling	Still Bottom Sludges	-	500	-	500	0.2
TOTALS		105,400	132,800	56,600	294,900	100

TABLE 6.11

ESTIMATED DISTRIBUTION OF WASTE RESIDUES
BY DISPOSAL PRACTICE - PETROLEUM SOLVENT
(KG OF SOLVENT LOSSES/YEAR)

Disposal Practice	Waste Residue	PLANT SIZE			Total (kg/yr)	%
		Small (kg/yr)	Medium (kg/yr)	Large (kg/yr)		
Recycled		-	-	-	-	-
Licensed						
Disposal	Still Bottom Sludges	4,300	-	29,800	34,100	43.7
	Filter Muck	-	-	14,700	14,700	18.8
	Cartridges	<u>-</u>	<u>1,600</u>	<u>3,000</u>	<u>4,600</u>	<u>5.9</u>
Sub Total		4,300	1,600	47,500	53,400	68.4
Unlicensed						
Disposal	Still Bottom Sludges	3,100	400	-	3,500	4.5
	Filter Muck	1,600	100	-	1,700	2.2
	Cartridges	<u>7,600</u>	<u>6,300</u>	<u>3,700</u>	<u>17,600</u>	<u>22.5</u>
Sub Total		12,300	6,800	3,700	22,800	29.2
Stockpiling	Still Bottom Sludges	1,900	-	-	1,900	2.4
TOTALS		18,500	8,400	51,200	78,100	100

6.4.2 Solvent Losses

Solvent losses from dry cleaning establishments include losses from the waste disposal of still bottom sludges, filter muck and spent cartridge filters; air emissions; contaminated water disposed to sewers; and minor losses as may occur through solvent remaining on dry cleaned fabric.

Quantities of solvent disposed of in waste residues were determined earlier in this section. Contaminated water from water separators on solvent reclaim equipment has been found to contain from 1 to 43 ppm of perchloroethylene (private correspondence with New Brunswick MOE). Although the total quantity of losses from waters to sewers was not quantified, overall losses would be minor. Air losses would be major due to the volatile nature of the solvent.

Quantities of perchloroethylene lost via air emissions were estimated using values obtained from a study conducted on dry cleaners in British Columbia (Environment Canada, 1983). This study determined that evaporation during processing accounted for as much as 90% of the total solvent losses. Total emissions of perchloroethylene ranged from as high as 150 kg of solvent per 1000 kg of clothing processed for poorly operated transfer facilities, down to as low as 18 kg/1000 kg for carefully controlled operations using refrigeration units. No similar data were available for petroleum solvent plants.

The estimated total solvent used by the dry cleaning industry by plant size and processing technology is given in Table 6.12 as 2,455,300 litres/year of perchloroethylene (4,026,700 kg/yr) and 1,654,400 litres/yr (1,240,800 kg/yr) of petroleum solvent. The values for perchloroethylene usage are within 10% of the total volume given by perchloroethylene manufacturers for solvent purchases in 1986 (Section 4.5). No actual values were obtainable for petroleum solvent purchases from solvent manufacturers.

Table 6.13 shows the expected quantities of solvent that would be lost via air emissions from each type of processing technology in perchloroethylene plants. Emissions of solvent from transfer units ranges from 100 to 150 kg/1000 kg of processing, while emissions from hot units can range from 49 to 75 kg/1000 kg. An average value of each range was used to calculate expected solvent emissions from each processing category. Air losses from refrigerated units was assumed to be 18 kg/1000 kg processing.

TABLE 6.12

ESTIMATED SOLVENT USE BY
DRY CLEANERS PROVINCE-WIDE

SIZE	PROCESS	SURVEY RESULTS			PROVINCE-WIDE	
		No. of Plants	Solvent (L/yr)	Usage (L/plant.yr)	No. of Plants	Solvent Usage (L/yr)
<u>Perchloroethylene</u>						
Small	Transfer	33	67,000	2,030	570	1,157,100
	Hot	22	29,000	1,320	352	464,600
	Refrigerated	4	2,000	500	28	14,000
Medium	Transfer	19	78,000	4,100	110	451,000
	Hot	18	49,000	2,720	56	152,300
	Refrigerated	11	14,000	1,275	33	42,100
Large	Transfer	15	85,000	5,670	17	96,400
	Hot	11	42,000	3,820	18	68,800
	Refrigerated	1	9,000	9,000	1	9,000
TOTAL						2,455,300 L/yr 4,026,700 kg/yr*
<u>Petroleum Solvent</u>						
Small	Transfer	10	42,000	4,200	105	441,000
Medium	Transfer	4	75,000	18,700	22	411,400
Large	Transfer	2	100,250	200,500	4	802,000
TOTAL						1,654,400 L/yr 1,240,800 kg/yr**

* Perchloroethylene = 1.64 kg/L

** Petroleum Solvent = 0.75 kg/L

TABLE 6.13

ESTIMATED AIR LOSSES OF PERCHLOROETHYLENE
FROM DRY CLEANING PLANTS IN ONTARIO

PROCESS	SIZE				SOLVENT EMISSIONS*	
		Solvent Usage (L/1,000 kg)	Solvent Purchases (L/yr)	Annual Dry Cleaning Processed (1,000's kg/yr)	(kg of perc/ 1,000 kg processing)	(kg/yr)
Transfer	Small	100	1,157,100	11,570		
	Medium	87	451,000	5,180		
	Large	38	96,400	<u>2,540</u>		
				19,290	115	2,218,350
Hot	Small	39	464,600	11,915		
	Medium	49	152,300	3,110		
	Large	42	68,800	<u>1,640</u>		
				16,665	62	1,033,230
Refrigerated	Small	29	14,000	485		
	Medium	23	42,100	1,830		
	Large	67	9,000	<u>135</u>		
				2,450	18	44,100
TOTALS						3,295,680 kg/yr

* Based on data from Environment Canada (1983)

The amount of processing done by each plant category was calculated by taking the average solvent "mileage" of each plant category, (Table 4.7, in terms of litres of solvent/1000 kg processing), and dividing this number into the annual solvent purchases from Table 6.12. This number was then multiplied by the solvent emission per 1000 kg of processing to give the overall air emissions per each category.

The most substantial amount of air solvent losses occurred in transfer establishments. The major cause of this is age of equipment, poor maintenance and operator carelessness. According to DCLI, the major source of solvent loss would be the tumbler itself, and not the transfer of clothing from the washer-extractor to the tumbler-dryer. In the tumbler, the major problems contributing to solvent losses would be back pressure from the coils, worn or damaged seals, and plugged lint filters.

6.4.3 Overall Mass Balance

The overall mass balances of solvent losses in dry cleaning establishments are presented in Table 6.14. Using the estimates developed in this report for waste disposal, and estimates for airborne losses from other sources, the overall mass balance for perchloroethylene closed within 11%. This is excellent accountability given the disparate sources of data and the extrapolations necessary to estimate losses.

In perchloroethylene plants, almost 32% of solvent purchases are lost via air emissions. This is within the same range as determined in the Environment Canada study in British Columbia. Waste residues account for a total 7.3%, with still bottom sludges containing 4.5%, filter muck 0.3% and cartridges 2.4%. Unaccounted solvent losses were totalled to be 11.0%, including losses to the sewer of contaminated water.

A satisfactory mass balance was not obtained for petroleum solvent plants, as values for air emission losses were unavailable. It is expected, however, that evaporative solvent losses would be substantial, as was the case with plants using perchloroethylene.

It is evident from Table 6.14 that the major environmental loss pathway from the dry cleaning industry in Ontario is air emissions, accounting for about 10 times the quantity of solvent lost through solid or liquid waste disposal.

TABLE 6.14

OVERALL SOLVENT MASS BALANCES

Route of Loss	Perchloroethylene		Petroleum Solvent	
	(kg/yr)	%	(kg/yr)	%
Still Bottom Sludges	181,900	4.5	39,500	3.2
Filter Muck	13,000	0.3	16,400	1.3
Filter Cartridges	100,000	2.5	22,200	1.8
Air Emissions*	3,295,680	81.7	Unknown	Unknown
TOTAL	3,590,580	89.0	-	-
Annual Solvent Purchase	4,026,700	100	1,240,800	100
Miscellaneous Losses	436,120	11.0	-	-

* Estimated value from Table 6.13

7.0 MANAGEMENT PRACTICES OF OTHER JURISDICTIONS

7.1 Regulations/Guidelines

United States

In the United States, the federal E.P.A. sets the standards on the regulation of wastes from the dry cleaning industry. Since September 22, 1986, all dry cleaners producing more than 100 kg of waste per month have been required to register an E.P.A. hazardous waste manifest. Prior to this time, the small quantities exemption level was 1000 kg/month. At the previous level, the majority of dry cleaners were exempt from using a hazardous waste manifest. With the 100 kg level, the majority of all dry cleaners are affected.

Cooked powder residues (from perchloroethylene plants only), still bottom sludges and spent cartridge filters with perchloroethylene or fluorocarbons are considered hazardous and are listed under the EPA hazardous waste number of F002. Still bottom residues containing petroleum solvent with a flash point less than 140°F are also considered hazardous under EPA hazardous waste number D001.

The EPA considers all cartridges from perchloroethylene plants hazardous, no matter what method of solvent recovery is used prior to disposal. Any exemption is opposed unless perchloroethylene levels are reduced to 0.02 ppm. To determine this exemption level, the EPA currently uses a "Vertical and Horizontal Spread" model, (VHS model), which will predict the concentration of an organic in a drinking well 500 feet from a landfill site, given the initial concentration of the organic as disposed of. This model is based on a leachate test which has been developed for 38 different organics.

Using the VHS model and a maximum acceptable level for perchloroethylene (in groundwater) of 0.07 ug/L, a cartridge disposed of in a landfill could not contain more than 0.02 ppm. As this value is physically unattainable with present technology, basically all cartridges are considered hazardous and unsuitable for landfill disposal.

The E.P.A. also implemented a ban on the landfill disposal of dry cleaning wastes as of November 8, 1986. The only options thus available to dry cleaners for disposal is

recycling and high-temperature incineration. This land-ban regulation exempts generators under 100 kg/ per month. If a dry cleaner is under 100 kg, wastes can be disposed of in landfills. However, this requires locating a landfill which would accept the waste, which is still classified as "hazardous".

EPA regulations may be superceded by state agencies. For example, some states may have zero exemptions while others have different forms to fill out for manifesting or obtaining ID numbers. Table 7.1 summarizes the different regulations and small quantities exemption in place in other jurisdictions in the United States and Canada.

Most other states which have final authorization to run their own hazardous waste programs follow the US E.P.A.'s lead in regulating dry cleaning wastes. Kansas and New York State differ slightly. In Kansas, if a cartridge is demonstrated to contain less than 2% perchloroethylene, disposal in a municipal landfill site is acceptable. This level is considered attainable by steam stripping. Over this level, cartridges are required to go to hazardous disposal sites. As well, the small quantity exemption in Kansas was reduced to 25 kg/month on July 1, 1986. New York state also has a 2% land-ban, where wastes with solvent content less than 2% can go to a hazardous waste landfill site. Above this level, wastes must either be recycled or incinerated.

At least 3 states, Minnesota, Tennessee and Nebraska are looking at enforcement exemptions which would allow for the disposal of cartridges into sanitary landfill sites. These states are trying to delist spent cartridges as a hazardous waste, and are specifically seeking a variance which excludes stripped cartridges with not more than 5 ppm perchloroethylene. They argue that another alternative to sending filters offsite or recycling is needed, since such facilities are not available in all states. Some states are also using the argument that stripped cartridges may actually serve as an environmental benefit, since the activated carbon in the cartridge would be almost completely free of perchloroethylene, and could theoretically absorb other toxics present in a landfill, such as household chemicals.

Canada

Under the Transportation of Dangerous Goods Act (TDGA) from Environment Canada, cartridges, still bottom sludges and filter muck with concentrations of perchloroethylene

TABLE 7.1

SUMMARY OF DRY CLEANING WASTE MANAGEMENT
PRACTICES OF OTHER JURISDICTIONS

Jurisdiction	Regulation	Small Quantities Exemption	Waste Registration Procedure
UNITED STATES			
Federal EPA	<p>Perchloroethylene: all cooked powder residue, still residues and spent cartridges considered hazardous</p> <p>Valclore: all still residues and spent cartridges considered hazardous</p> <p>Petroleum Solvent: still residues with a flash point less than 140°F considered hazardous</p>	All combined waste streams under 100 kg/month are exempt	<p>All dry cleaners must register with generator registration and obtain an EPA identification number</p> <p>Perc and valclore wastes classified under EPA Hazardous Waste No. F002</p> <p>Varsoi classified under EPA Hazardous Waste No. 0501</p>
Kansas	Perchloroethylene: all cooked powder, sludges and spent cartridges with more than 2% perc by weight are considered hazardous. If 2% or less, may dispose of in sanitary landfill (2% land-ban)	All combined waste streams under 25 kg/month are exempt	Some registration procedure as with EPA, but different manifest forms
Ohio, Pennsylvania, Texas	as per EPA	as per EPA	as per EPA
New York	Perchloroethylene: all waste residues with more than 2% perc by weight are considered hazardous. If less than 2%, may dispose of in hazardous waste landfill	as per EPA	Same regulation procedure as with EPA, but different manifest forms
Michigan, Connecticut, California	as per EPA	No small quantities exemption	Same registration procedure as with EPA, but different manifest forms and identification numbers
Minnesota, Tennessee, Nebraska	Currently regulated as per EPA Trying to deust cartridges	No small quantities exemption	Same registration procedure as with EPA, but different manifest forms and identification numbers
CANADA			
British Columbia	Currently no regulations Under review	-	Waste transportation manifest with British Columbia identification number and a Transport of Dangerous Goods Act I.D. number if over 100 ppm perchloroethylene. Must register with generator registration and obtain identification number
Alberta, Manitoba	Currently no regulations - will follow Ontario's lead	-	Waste transportation manifest with TDGA identification number
New Brunswick, P.E.I., Nova Scotia	As of 30 November 1986, no dry cleaning waste residue can be disposed of to a landfill site ("land-ban")	No small quantities exemption	Waste transportation manifest with TDGA identification number. Must register with generator registration and obtain identification number.

more than 100 ppm would be regulated. This entails the posting of appropriate placards on the transportation vehicle displaying the hazardous nature of the material being transported, as well as completion of waste transportation manifests.

Most provinces in Canada do not regulate wastes from the dry cleaning industry. The main exception is the Maritime provinces (excluding Newfoundland), which have placed a landfill ban on all dry cleaning wastes as of November 30, 1986. Dry cleaners must store their wastes and have them hauled out of the province. Initially, an upper limit of perchloroethylene in cartridges, below which disposal was acceptable, was considered. However, the idea was discarded since it was determined that it would be too difficult to enforce.

British Columbia currently has no regulations for dry cleaning wastes but is in the process of conducting a study to determine what, if any, regulations should be implemented. Alberta and Manitoba also have no regulations in place, and are waiting for Ontario's decision prior to making any changes.

7.2 Monitoring Procedure

United States

The requirements of the EPA for dry cleaners who generate more than 100 kg of hazardous waste in any calendar month become subject to the federal agency's small quantity generated requirements. These requirements include:

- o having an EPA identification number for each plant location
- o filling out multiple-copy manifests for each waste shipment
- o shipping all wastes in approved containers using only licensed haulers who will take it to an approved hazardous waste facility
- o each plant must designate an emergency contact person who will be available 24 hours a day by telephone to be notified in case of a spill or other emergency.

These rules apply to dry cleaners when their wastes exceed 100 kg/month.

Often, dry cleaners may find that in some months they exceed the 100 kg benchmark, while in others they are below this level. If the 100 kg limit is not reached in a calendar month, the cleaner is classed as a conditionally exempt small quantity generator. Conditionally exempt generators are required to identify all hazardous wastes they generate, send the waste to a hazardous waste facility or other facility approved by the state, and never accumulate more than 100 kg of waste on site.

Most other states follow EPA's waste registration procedure. Some may use different manifest forms or ID numbers, as indicated in Table 7.1.

Canada

The transport of perchloroethylene in concentrations greater than 100 ppm is regulated under the TDGA with the use of a waste transportation manifest and a TDGA identification number. British Columbia, as with Ontario, also register all wastes containing perchloroethylene. The Maritime provinces (excluding Newfoundland) also follow a waste registration procedure as in the United States, with proper identification numbers and multiple-copy manifests required.

8.0 CONCLUSIONS AND RECOMMENDATIONS

8.1 Conclusions

The following conclusions have been drawn from the information presented in this report.

- o The total quantity of perchloroethylene disposed of in wastes from dry cleaning plants in Ontario totalled approximately 294,900 kg in 1986, or 7.3% of the total volume of solvent purchased annually. The majority of solvent losses (almost 82%) are via air emissions.
- o Waste residues from petroleum solvent plants contained 78,100 kg of solvent, equalling 6.3% of the total solvent purchases in 1986 for the dry cleaning industry in Ontario. The majority of solvent losses are also likely to be through air emissions.
- o Approximately 90% of all dry cleaning plants in Ontario use perchloroethylene as the cleaning solvent, with the balance using petroleum solvent (about 10%) or fluorocarbons (0.2%).
- o Transfer is the most commonly used dry cleaning technology, with approximately 64% of the plants using this process.
- o Distillation Units are used in approximately 88% of the perchloroethylene plants. Diatomaceous earth filtration is used, in only 11% of all dry cleaning plants in Ontario, while close to 90% use cartridge filters.
- o Almost all (99%) still bottom sludges containing perchloroethylene are accumulated on-site, and then sent to recyclers for reclaim of the solvent; however, 13% of the small plants in Ontario do not follow this practice.
- o Almost all (97%) still bottom sludges from petroleum solvent operations are hauled to industrial landfill sites, while 2% use municipal landfills by way of municipal refuse disposal bins.

- o Cooked filter muck from perchloroethylene operations is disposed of to either municipal refuse (24% by weight) or to a secure landfill (71%). The majority of the filter muck going to the secure landfill site comes from a number of plants which operate under the same chain.
- o Petroleum solvent cooked filter muck is almost entirely disposed of to industrial landfill (99%).
- o About 90% of all cartridge filters from perchloroethylene cleaning are disposed of to municipal garbage; the majority (83%) of these cartridges come from medium and large-size plants.
- o The most common method used to recover perchloroethylene from spent cartridges prior to disposal is the cabinet/sniffer arrangement. Forty-one percent of the dry cleaning establishments which use cartridges practice this form of recovery.
- o Steam-stripping of cartridges to recover perchloroethylene is practiced in less than 20% of the dry cleaning plants in Ontario.
- o It appears that about 1% perchloroethylene in spent filter cartridges is the lowest concentration achievable by any of the methods currently used to remove solvent from cartridges.
- o Only 34% of the cartridges from petroleum solvent plants are disposed of with municipal refuse; the remainder are hauled to an industrial landfill.
- o The concentration of perchloroethylene in still bottom sludges averaged 28.5%, with cooked filter muck averaging 24.4%. Reduced perchloroethylene content in sludges in the 10 to 15% range should be routinely achievable by the industry.

8.2 Recommendations

During the course of this study, it became apparent that there was no information source readily available from which dry cleaners obtain retail information on proper disposal methods and other areas of concern. Many dry cleaners were confused by conflicting answers given by suppliers of equipment, recyclers, and ministry officials. As well, it was found from the survey that a large percentage of the small plants, 13%, dispose of their perchloroethylene still bottom sludges to municipal refuse, likely due in part to ignorance as to proper disposal methods required by the Ministry of the Environment.

The DCLI will provide information to its members if requested, and will assist the Ministry to the extent of its ability on the development of an approach to manage dry cleaning wastes. Non-DCLI members, which represent approximately half of the dry cleaning industry, would not be as well-informed. It is thus recommended that the Ministry of the Environment take steps to advise all dry cleaners in Ontario on the regulations and options available to them for waste disposal practices. The DCLI could work with the MOE to inform DCLI members of any policies enacted by the MOE. Non-members would need to be informed via direct contact by the MOE with individual cleaners.

Although it was not in the original terms of reference, it appears that there is potential for significant reductions in airborne emissions of solvent. This could be achieved by enforcing higher solvent mileage, possibly through a reporting requirement. The disparity between values for small, medium and large plants noted in Table 4.7 seems to indicate that transfer, and to some degree, hot units are not achieving peak efficiency. The DCLI has suggested that solvent mileage in the range of 40 to 50 L/1000 kg (200 to 250 lbs/gallon) is consistently achievable even with transfer equipment, through the application of minor changes in operating and maintenance procedures (e.g., gasket replacement) particularly for reclaimer and adsorber operation. It has been suggested that these changes could increase profitably through reduced solvent purchases, and decrease the losses of solvent to the environment.

Upon return of the questionnaire, each was reviewed thoroughly to ensure complete and reasonable responses. In some cases, the answers did not seem logical, so a telephone follow-up to these plants was made to confirm and/or correct the questionable answers.

2.3.3 Site Visits and Sampling

Sampling of wastes from dry cleaning plants was conducted to obtain information on solvent content in still bottom sludges, filter muck and spent filter cartridges. Plants were chosen to represent all possible combinations of plant size, solvent type and processing technology, as discussed further in Section 5.1 and Section 5.2. Resampling was done at one selected plant to allow for an estimation of in-plant variability. Thus both plant-to-plant variations and in-plant variations were obtained.

Plant selection was also based on convenience of plant location to the BEAK office, with site visits only in the central and west-central regions. A total of 16 plants were sampled with the focus primarily on hot and transfer technology using perchloroethylene, as these represent up to 90% of the industry in Ontario.

2.3.4 Data Evaluation

Data evaluation was performed in two stages. The initial step involved the evaluation of the questionnaires. This data was processed to obtain the distribution of dry cleaning establishments by size (in terms of quantity of clothing processed per month), processing technology, solvent use and quantities and types of wastes generated.

The second stage in the data evaluation involved the extrapolation of results obtained from the questionnaire to province-wide estimates. This information also helped to provide a profile on the dry cleaning industry in Ontario.

The results determined from the sampling of wastes from individual dry cleaners were used in conjunction with the questionnaire results to provide an estimate of solvent losses to the environment via wastes generated. A mass balance was then made to quantify solvent losses to determine the overall fate of solvents used in the dry cleaning industry.

- Environment Canada (1983), "Investigation into losses to the environment during processing or usage of selected hydrocarbon solvents", Environmental Protection Services, British Columbia.
- International Fabricare Institute (1986), "Reduction of solvent content in Cartridges", IFI Technical Bulletin T-568.
- International Fabricare Institute (May 1984), "Still residue and cooker muck update", IFI Fabricare News, Research Briefs.
- International Fabricare Institute (1983), "Reducing perc content in residues", IFI Technical Bulletin, T-560.
- Ontario Ministry of Labour (1982), "Occupational exposure to certain chlorinated hydrocarbons", prepared by Concord Scientific Corporation and M.M. Dillon Ltd.

10.0 ACKNOWLEDGEMENTS

BEAK Consultants Limited wish to acknowledge the efforts and co-operation of all those who participated in this project. In particular, thanks go to Mr. Ken Adamson and Ms. Nancy Derrer of the Dry Cleaners and Launderers Institute (DCLI) for their co-operation and support for the project in providing information and reviewing our work. Thanks go to all the representatives of individual dry cleaning companies who took the time to complete questionnaires, respond to our telephone calls, and give permission to conduct sampling and process review visits. Thanks also go to Mr. Bob Breeze and Mr. George Rocoski of MOE for their assistance throughout the project and review of the report.

APPENDIX I

ESTABLISHMENT LISTING

[illegible]

[illegible]

BUSINESS NAME

ADDRESS

COMMUNITY

F40 FAC TELEPHONE REGION

38	3 SINK CLEANERS	1314 JUNE	1060010	0M	MS254	416249931	38
77	RYE CLEANERS & TAILORS	4389 1/2 CORWELL AV	1060010	0M	MS389	416461021	38
1	A & A CLEANERS	2809 EQUILIBRIUM I	1060010	0M	MS229	416264397	38
9	1 HOUR CLEANERS	1327 TONGUE	1060010	0M	MS276	416363023	38
9	1 HOUR CLEANERS	2061 BAINBRIDGE AV	1060010	0M	MS338	416369802	38
1	165 CLEANERS & COIN	651 THE BOUTHERS	1060010	0M	MS316	4162521908	38
1	165 CLEANERS	2500 EQUILIBRIUM	1060010	0M	MS384	416264397	38
1	165 CLEANERS	2378 EQUILIBRIUM E	1060010	0M	MS384	416264397	38
1	165 CLEANERS	871 BLONDIN W	1060010	0M	MS384	416264397	38
1	165 CLEANERS	2101 EQUILIBRIUM	1060010	0M	MS384	416264397	38
1	165 CLEANERS	2801 EQUILIBRIUM	1060010	0M	MS384	416264397	38
1	165 CLEANERS	4044 SHEPHERD AV E	1060010	0M	MS384	416264397	38
1	165 CLEANERS	55 TOWN CENTER COURT	1060010	0M	MS384	416264397	38
1	165 CLEANERS	519 RT FLEMING	1060010	0M	MS384	416264397	38
1	165 CLEANERS	640 ROGERS RD	1060010	0M	MS384	416264397	38
1	165 CLEANERS	2052 BUREN E	1060010	0M	MS384	416264397	38
1	165 CLEANERS	5 HIGHLAND	1060010	0M	MS384	416264397	38
1	165 CLEANERS	3319 BATHURST	1060010	0M	MS384	416264397	38
1	165 CLEANERS	531 BATHURST AV	1060010	0M	MS384	416264397	38
1	165 CLEANERS	9 UPRIDGE BLVD	1060010	0M	MS384	416264397	38
1	165 CLEANERS	210 WESTON	1060010	0M	MS384	416264397	38
1	165 CLEANERS	852 TONGUE	1060010	0M	MS384	416264397	38
1	165 CLEANERS	1070 BLONDIN W	1060010	0M	MS384	416264397	38
1	165 CLEANERS	3073 BATHURST W	1060010	0M	MS384	416264397	38
1	165 CLEANERS	2076 AVENUE RD	1060010	0M	MS384	416264397	38
1	165 CLEANERS	607 BATHURST	1060010	0M	MS384	416264397	38
1	165 CLEANERS	21 MORTLE RD	1060010	0M	MS384	416264397	38
1	165 CLEANERS	121 BATHURST	1060010	0M	MS384	416264397	38
1	165 CLEANERS	5306 S. EQUILIBRIUM E	1060010	0M	MS384	416264397	38
1	165 CLEANERS	4118 BATHURST	1060010	0M	MS384	416264397	38
1	165 CLEANERS	BATHURST MONROE PLAZA	1060010	0M	MS384	416264397	38
1	165 CLEANERS	5980 BATHURST	1060010	0M	MS384	416264397	38
1	165 CLEANERS	3693 BATHURST	1060010	0M	MS384	416264397	38
1	165 CLEANERS	244 BLONDIN W	1060010	0M	MS384	416264397	38
1	165 CLEANERS	1372 BATHURST	1060010	0M	MS384	416264397	38
1	165 CLEANERS	287 CORWELL AV	1060010	0M	MS384	416264397	38
1	165 CLEANERS	531 TONGUE	1060010	0M	MS384	416264397	38
1	165 CLEANERS	1508 BATHURST AV	1060010	0M	MS384	416264397	38
1	165 CLEANERS	244 BUREN	1060010	0M	MS384	416264397	38
1	165 CLEANERS	2460 EQUILIBRIUM	1060010	0M	MS384	416264397	38
1	165 CLEANERS	2175 EQUILIBRIUM E	1060010	0M	MS384	416264397	38
1	165 CLEANERS	1379 WILSON AV	1060010	0M	MS384	416264397	38
1	165 CLEANERS	106 BATHURST	1060010	0M	MS384	416264397	38
1	165 CLEANERS	1161 ST CLARK W	1060010	0M	MS384	416264397	38
1	165 CLEANERS	649 1/2 RT FLEMING	1060010	0M	MS384	416264397	38
1	165 CLEANERS	1754 VICTORIA PARK	1060010	0M	MS384	416264397	38
1	165 CLEANERS	727 BOURBON	1060010	0M	MS384	416264397	38
1	165 CLEANERS	2112 BATHURST CIR	1060010	0M	MS384	416264397	38

BUSINESS NAME

ADDRESS

COMMUNITY

PRO PAC TELEPHONE REGION

MODEL CUSTOM CLEANERS	1879 INDEPENDENT	1060410	OM	M6187	416567898	3R
MORRISON CLEANERS	1274 MORRISON AV	1060410	OM	M6184	416531729	3R
MR GEORGE ONE HOUR CLEANERS	1218 KING W	1060410	OM	M6166	416532102	3R
MR LEE S DAY CLEANING	705 KING W	1060410	OM	M5208	416535766	3R
N & S CLEANERS	416 EALINGTON	1060410	OM	M8745	416233196	3R
NEIGHBORHOOD CLEANERS	260 MURPHY	1060410	OM	M5362	416522155	3R
NEW BOWAZA CLEANERS 1	1706 AVENUE RD	1060410	OM	M5316	416781933	3R
NEW CENTURY CLEANERS 1	2412 AMESITION RD	1060410	OM	M1412	416267265	3R
NEW COLLEGE CLEANERS 1	353 COLLEGE HOSITE RD	1060410	OM	M5115	4169232931	3R
NEW FAMILY CLEANERS 1 SHIRT	952 EOLAN	1060410	OM	M6374	416621280	3R
NEW FENHOUSE CLEANERS	273 FENHOUSE W	1060410	OM	M5187	4167819242	3R
NEW STAR CLEANERS	1841 LORANCE AV E	1060410	OM	M6176	416534355	3R
NEW SISK ONE-HOUR CLEANERS	1100 YONGE	1060410	OM	M5216	4165213107	3R
NEW WAY CLEANERS 1 LAUNDRERS	2281 PARK W	1060410	OM	M5111	4167666211	3R
NORFOLK CLEANERS 1 CLEANERS	849 COLLEGE	1060410	OM	M6181	4165366211	3R
NORTH ARI CLEANERS	426 WILSON	1060410	OM	M5157	4168232506	3R
NORTHMOORE CLEANERS	246 CANTON	1060410	OM	M1114	4162414720	3R
NORTHON CLEANERS	3445 ST CLAIR E	1060410	OM	M2326	4164931454	3R
NU-BRITE CLEANERS	2162 EDLATION W	1060410	OM	M5129	4169215903	3R
NYMEX CLEANERS	4789 LESLIE	1060410	OM	M6159	4162479306	3R
O-MISTER CLEANERS	274 HILTON RD	1060410	OM	M6189	4165884403	3R
ODDPALE CLEANERS	1640 MIEN W	1060410	OM	M6187	4164234479	3R
ONE CLEANERS	955 PARK	1060410	OM	M4130	4164234479	3R
ONE HOUR CLEANERS	170 EDLATION E	1060410	OM	M4164	4164846921	3R
ONE HOUR DRY CLEANING DAY	1414 YONGE	1060410	OM	M4296	4161808970	3R
ONE HOUR DRY CLEANING DAY	337 BIRCH W	1060410	OM	M5107	4169770207	3R
ONE HOUR DRY CLEANING DAY	640 PINECH E	1060410	OM	M5126	4162353738	3R
ONE HOUR DRY CLEANING DAY	2298 ACLE	1060410	OM	M6170	4162470057	3R
ONE HOUR DRY CLEANING DAY	2185 LANE SHUT MI W	1060410	OM	M6187	4162514373	3R
ONE HOUR DRY CLEANING DAY	790 EDLATION E	1060410	OM	M6121	4164259744	3R
ONE HOUR DRY CLEANING DAY	744 MANNING RD	1060410	OM	M1429	4165336181	3R
ONE HOUR DRY CLEANING DAY	385 SHADOWN RD	1060410	OM	M5121	4164830721	3R
ONE HOUR DRY CLEANING DAY	2455 TORONTO	1060410	OM	M4246	4164850900	3R
ONE HOUR DRY CLEANING DAY	3210 YONGE	1060410	OM	M4072	4164895557	3R
ONE HOUR DRY CLEANING DAY	2290 HUNTERS W	1060410	OM	M6134	4165375161	3R
ONE HOUR DRY CLEANING DAY	2141 KILLING	1060410	OM	M5480	4167433781	3R
ONE HOUR DRY CLEANING DAY	755 JAMIL	1060410	OM	M6483	4167679371	3R
ONE HOUR DRY CLEANING DAY	2619 ISLINGTON	1060410	OM	M9224	4162423912	3R

BUSINESS NAME

Fry Cleaners

ADDITIONS

COMMUNITY

PRO PAC	TELEPHONE	REGION
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Ken C. Kleiers

[illegible]

BUSINESS NAME

Mr. Cleary:

ALIKESS

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COMMUNITY

L.M. STEVENS ET AL.

CV-1 04-1

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RELIGION IS ANOTHER

6134482135 41

HOMEWORK 1: CLIFFORDS

SYNOPSIS

CLASS CLASSES

MEYER KIVICKI CONSULTANTS LTD.

KANATA CLEANERS

LONG ISLAND CEMENT CO.

07/16/98

PAUL H. LEE

RICHARD CLARK AND K. S.

KOGAKU S. YAGI

STEWART FOR COLUMBIA

APPENDIX 2

SAMPLE QUESTIONNAIRE



CLEANERS AND LAUNDERERS INSTITUTE (ONTARIO)

September 18, 1986

N O T I C E

The Ontario Ministry of the Environment is evaluating the hazardous waste management practices of the Ontario dry cleaning industry.

Beak Consultants Limited has been chosen as the contractor to undertake this project.

Beak, in close cooperation with DCLI, is sending out questionnaires to 150 selected plants, and eventually will sample cartridges and muck at 20 of these to determine the extent of solvent loss through waste disposal practices.

The cooperation of plants receiving questionnaires is requested and will be appreciated; responses are to be returned by October 31, 1986. All information supplied will be kept confidential.

Questions can be directed to K. Adamson, DCLI, or J.M. Laplante, Beak Consultants at (416)522-4651 and (416)671-2600 respectively.

QUESTIONNAIRE

TO BE RETURNED BY OCTOBER 31, 1986 TO:

BEAK CONSULTANTS LIMITED
6870 GOREWAY DRIVE
MISSISSAUGA, ONTARIO
L4V 1P1

ATTENTION: J.M. LAPLANTE

NOTE

If you are only a depot, please forward this questionnaire to the main plant that handles your dry cleaning.

CONFIDENTIALITY OF INFORMATION

Information obtained from this questionnaire will be used solely to provide industry wide ranges and averages of the data requested. Individual plant responses will be retained by Beak Consultants Limited, as confidential information and will not be released to the Ministry of the Environment.

Questionnaire No. _____

1. Company Name: _____
Address: _____
Contact Name and Telephone No.: _____
2. Number of dry cleaning plants operated: _____
3. Ontario Waste Generator Number(s) for above (attach separate sheet as required):

4. DCLI Member: Yes _____ No _____

The following questions should be answered for each type of solvent used (if more than one used).

5. Name of solvent used: _____
6. Monthly quantity of dry cleaning processed: _____ lb., or
_____ kg
7. Of the quantity in Question 6, how much would be _____ lb., or
_____ kg
classed as "industrial dry cleaning" (rags,
uniforms):

8. Quantity of solvent purchased annually: _____ litres, or
 _____ gallons
9. Type of technology used (check one): Transfer _____
 Hot Type Enclosed _____
 Refrigerated _____
10. Total capacity of washers or washer/extractors: _____ lb., or
 _____ kg
11. How many solvent reclaiming tumblers do you operate? _____
12. How many conventional tumblers do you operate? _____
13. How many solvent distillation units do you operate? _____
14. How many diatomaceous earth filters do you operate? _____
15. How many of each type of cartridge filters do you operate?

Standard size _____

Jumbo (large) size _____

16. Estimate the yearly quantities and types of the following wastes that you dispose and how you dispose of them (quantities in lb. per year, gallons per year, cartridges per year) (disposed to municipal garbage, industrial garbage, recycler, returned to supplier):

<u>Waste</u>	<u>Quantity</u>	<u>Disposed to</u>
Still Bottoms	_____	_____
Filter Muck	_____	_____
Plain Paper Cartridges	_____	_____
Carbon Core Cartridges	_____	_____
Solid Carbon Cartridges	_____	_____
Absorptive Type Cartridges	_____	_____
Other, explain: _____	_____	_____

17. Check the in-plant method you use to recover solvent from cartridges:

No method used _____

Cabinet/tumbler ventilation _____

Steam stripping _____

Other (explain) _____

18. List the flash points, solvent content and how this information was obtained (to the best of your knowledge) for the wastes identified in Question 16.

<u>Waste</u>	<u>Flash Point</u> (°C or °F)	<u>Solvent Content</u> (% or ppm) (parts per million)	<u>How</u> <u>Obtained</u> (lab estimate)
Still Bottoms	_____	_____	_____
Filter Muck	_____	_____	_____
Plain Paper Cartridges	_____	_____	_____
Carbon Core Cartridges	_____	_____	_____
Solid Carbon Cartridges	_____	_____	_____
Absorptive Type Cartridges	_____	_____	_____
Other, explain:	_____	_____	_____

19. If your waste goes to the municipal garbage, have you tried to have it picked up by some other company or means? Yes _____ No _____

20. If the answer to Question 19 was yes, what was the problem in having your waste picked up? (Explain): _____

21. Have you had a problem in obtaining information or advice on waste disposal from either the Ministry of Environment or DCLI? Yes _____ No _____

If yes, explain: _____

If no, have you tried to obtain information? Yes _____ No _____

22. If there are differences in the quantity of dry cleaning you process during the year, indicate below which months are heavy (H), light (L) or average (A):

January _____
February _____
March _____
April _____
May _____
June _____

July _____
August _____
September _____
October _____
November _____
December _____

23. What method would you use, how much would it cost, and why would you choose that method if your waste is considered hazardous and requires special disposal methods?

<u>Method</u>	<u>Cost</u>	<u>Reason</u>
Industrial Haul	_____	_____
Solvent Recycler	_____	_____

Install new equipment to make
waste non-hazardous

Install new equipment to reduce
waste quantity

Sell or go out of business

Other

24. Are you interested in having your sludges or cartridges analyzed as part of this study? Yes _____ No _____

APPENDIX 3

ANALYTICAL METHODS

APPENDIX 3

BAS ANALYTICAL PROCEDURE FOR PERCHLOROETHYLENE AND PETROLEUM SOLVENT

1.0 CARBON, SLUDGES, FILTER MUCK

1.1 Extraction

A representative portion of carbon is taken (about 50 mg).

The charcoal is added to a small 2 ml septum cap vial containing 1 ml CS₂. The vial is tightly capped.

The charcoal is desorbed by occasional mixing for 1.0 hours. Extract is ready for GC/FID.

1.2 GC Conditions

Column: DB - 1 J+W capillary column. 0.32 mm x 15 m., film thickness 0.25 μ m.
Injection Temp.: 200°C.
Oven Temp. Prgm.: 50°C for 2 mins., then 7°C/min to 200°C, hold for 5 mins.
Detector: Flame Ionization Detector.
Detector Temp.: 280°C.
Carrier Gas: Hydrogen 8 ml/min.
Detector Gases: Hydrogen 30 mls/min. Air 200 mls/min.

2.0 FILTER PAPER

2.1 Extractions

A representative sample of filter paper is taken, about 50 grams.

The filter paper is extracted by soxlet extractor using dichloromethane as a solvent for 4.0 hours.

The final volume is made up to 200 ml in dichloromethane, and ready for GC/FID.

2.2 GC Conditions

Column: DB - 1 J+W capillary column. 0.32 mm x 15 m., film thickness 0.25 μ m.
Injection Temp.: 200°C.
Oven Temp. Prgm.: 50°C for 2 min., then 7°C/min to 200°C, then hold for 5 mins.
Detector: Electron Capture Detector Ni⁶³.
Detector Temp.: 300°C.
Carrier Gas: Hydrogen 8 ml/min.
Make-Up Gas: Nitrogen 20.25 ml/min.

3.0 QA/QC

- (i) 10% replication.
- (ii) sample fortification (spiking).
- (iii) extraction or desorption efficiency.
- (iv) EPA reference solutions.

ANALYTICAL METHODS FOR
DETERMINING PERCHLOROETHYLENE
(PCE) AND PETROLEUM SOLVENT RESIDUES

I. PCE in Activated Carbon

A. Desorption of PCE from Darco Activated Carbon.

Methods for desorbing organic solvents from activated carbon with carbon disulfide (CS_2) have been described in the literature (1, 2, 3). We have adopted a method similar to these.

1. Determination of Desorption Efficiency of PCE from Darco Activated Carbon with CS_2 .

Five activated carbon samples (ca. 0.2000g) were analytically weighed into 30 ml screw cap vials. To four of the vials, 10 μl (16.2 mg.) of PCE was injected directly onto the carbon. The fifth was a blank. The samples were left to stand overnight to ensure complete adsorption. The following day, 2 ml of CS_2 were pipetted into each vial. Samples were shaken for 30 minutes. Just prior to analysis, 2 ml of CS_2 containing an internal standard were added to the sample to be analyzed.

2. Internal Standard and Calibration Mixture Preparation.

The internal standard was prepared by adding a small amount (ca. one drop of internal standard, we used cyclohexane) to approximately 100 ml of CS_2 . A standard PCE solution was prepared by analytically weighing 0.1 gm of PCE into a 100 ml volumetric and filling with carbon disulfide.

The calibration mixture is prepared by pipetting 5 ml of the internal standard solution and 5 ml of the standard PCE solution into a vial and mixing.

3. GLC Analysis (Gow Mac 750 FID).

GLC conditions were as follows:

Column: 6' x 1/8", 0.1% SP-1000 on Carbowack C 80/100.
H₂ Flow: 20 ml/min.
N₂ Flow: 20 ml/min.
Air Flow: 250 ml/min.
Sensitivity: 10⁻¹².
Attn: 8.
Column Temp.: 160°C (isothermal).
Inj. Temp.: 175°C.
Det. Temp.: 175°C.
Sample Volume: 1 ul.

B. Analysis of Activated Carbon.

1. Desorption of PCE from Darco Activated Carbon with CS₂.

Core samples were taken from the carbon chamber of the cartridges being sampled by inserting a 5/8" I.D. pipe along the length of the chamber.

Sub-samples (ca. 0.2000g) were weighed into tared 5 ml screw cap vials. The samples were then handled in an identical manner as those in Section A-1.

2. Internal Standard and Calibration Mixture Preparation.

Same as Section A-2.

3. GLC Analysis.

GLC conditions were identical to those in Section A-3.

4. Calculations.

The integrator (HP-3390A) was programmed to give sample concentration of PCE in units of gm/l or mg/ml directly. Amounts of PCE desorbed were then determined by multiplying the sample concentration by the sample volume. Percent PCE in the sample could then be determined from the sample weight after correcting for the desorption efficiency. Multiplying the percent PCE in the carbon by the total carbon weight in the cartridge then yields the total PCE in the cartridge carbon.

C. Extraction of PCE from Paper with Methylene Chloride (CH_2Cl_2) in a Soxhlet Extractor.

1. Extraction Efficiency of PCE from Paper.

For this method, a large Soxhlet Extractor was used (Note 1). A sample of paper (4" x 2.5" x 2") taken from a new cartridge was placed in an extraction thimble (100 mm x 60 mm) and dropped into the Extractor. An analytically-weighed amount of PCE was added to the paper sample. Some samples were then treated with water. Five hundred millilitres of CH_2Cl_2 were added to the flask and approximately 200 ml were added to the Extractor. After extracting several hours, the Extractor was flushed with a few portions of fresh solvent. the contents of the flask were then transferred to a 1 L volumetric flask. Chlorobenzene (0.300-1.000 g) was added as internal standard; the flask was filled and shaken. Four samples were analyzed in this manner.

2. Calibration Mixture.

A calibration mixture was prepared by adding PCE (ca. 0.1000 g) to a 100 ml volumetric flask, filling with CH_2Cl_2 and shaking. From this flask, 10 ml was pipetted to another 100 ml volumetric flask. To this flask, chlorobenzene (ca. 0.1000 g) was added. The flask was filled with CH_2Cl_2 and shaken. This calibration mixture contained 0.0100 g PCE/100 ml and 0.1000 g chlorobenzene/100 ml.

3. GLC Conditions.

Identical to those in Section I-B-3, except:

Initial Temp.: 160°C.
Initial Time: 2 min.
Ramp: 20°C/min.
Final Temp.: 200°C.
Final Time: 5 min.
Sample Volume: 4 µl.

4. Results.

PCE recovery from the samples ranged from 90-100%.

D. Analysis of Paper and Dirt from Stripped Cartridges.

1. Extraction of PCE from Paper and Dirt with CH₂Cl₂ in Soxhlet Extractor.

Representative samples of paper and dirt (approximately 100 gm) were taken from each cartridge with a 2" hole saw.

Samples from the same cartridge were extracted with the same portion of solvent (total volume approximately 1 litre).

2. Calibration Mixture.

Prepare in an identical manner to Section C-2. (Note 2).

3. GLC Analysis.

Column: 10' x 1/8" SS 3% SP-1500, 80/100 Carbopack B.
Initial Temp.: 175°C.
Initial Time: 4 min.

Ramp: 5°C/min.
Final Temp.: 200°C.
Final Time: 16 min.
Attn: 8.
Sens.: 10^{-12} .
N₂ Pres.: 78 psi.
H₂: 15-20 ml/min.
Air: 250 ml/min.
Sample Volume: 5 ul.

Note 1: Extractor inner diameter: 65 mm; height to siphon arm: 120 mm; total capacity: approximately 500 ml. Distillation flask capacity: 1000 ml.

Note 2: For samples low in PCE, the calibration mixture was prepared by dilution of higher concentration calibration mixtures.

- 1) Otterson, E.J. and Guy, C.U. Trans 26th Annual Meeting, A.C.G.I.H., 37 (1964).
- 2) Kupel, R.E., et.al., A.I.H.A., J.31,225 (1970).
- 3) Mueller, F.X. and Miller, J.A., Amer. Lab. 6(5), 49 (May, 1974).

APPENDIX 4

ESTIMATED WASTE GENERATION BY MOE REGION



TABLE A4.1: WASTE SOLVENT RESIDUALS BY GEOGRAPHIC DISTRIBUTION - REGION I

Size	Process	No. of Plants	Stills	No. of Plants Using		Stills (kg/yr)	Solvent Losses		Cartridges (kg/yr)
				Earth Filters	Diatomaceous		Filter Muck		
<u>Perchloroethylene</u>									
Small	Transfer	68	47	6		2900	300		3700
	Hot	42	34	2		3400	100		1500
	Refrigerated	3	2	-		200	-		400
	Subtotal	113	83	8		6500	400		5600
Medium	Transfer	13	12	1		6500	50		4700
	Hot	7	7	1		2500	600		300
	Refrigerated	4	3	1		150	150		200
	Subtotal	24	22	3		9500	800		5200
Large	Transfer	2	2	1		900	500		300
	Hot	2	2	-		4000	-		400
	Refrigerated	-	-	-		-	-		-
	Subtotal	4	4	1		4900	500		700
<hr/>									
Total		141	109	12		20900	1700		11500
<u>Petroleum</u>									
Small	Transfer	12	6	4		1200	200		900
	Hot	2	0	1		-	-		700
	Refrigerated	1	1	-		9400	-		1700
Large	Transfer	15	7	5		10600	200		3300
	Total								

TABLE A4.2:
WASTE SOLVENT RESIDUALS BY GEOGRAPHIC
DISTRIBUTION - REGION 2

Size	Process	No. of Plants	No. of Plants Using			Sludges (kg/yr)	Solvent Losses		Cartridges (kg/yr)
			Stills	Diatomaceous Earth Filters	Cartridges		Filter Muck (kg/yr)		
<u>Perchloroethylene</u>									
Small	Transfer	68	47	6	62	2900	300	3700	
	Hot	42	34	2	36	3400	100	1500	
	Refrigerated	3	2	-	3	200	-	400	
	Subtotal	113	83	8	101	6500	400	5600	
Medium	Transfer	11	11	-	11	5900	-	4300	
	Hot	6	6	1	5	2200	600	300	
	Refrigerated	3	2	-	2	300	-	100	
	Subtotal	20	19	1	18	8400	600	4700	
Large	Transfer	4	4	1	3	1900	600	1000	
	Hot	4	4	-	3	8000	-	600	
	Refrigerated	-	-	-	-	-	-	-	
	Subtotal	8	8	1	6	9900	600	1600	
Total			141	110	10	125	24800	1600	11900
<u>Petroleum Solvent</u>									
Small	Transfer	12	6	4	10	1200	200	900	
	Hot	2	1	1	2	-	-	700	
	Transfer	1	1	-	1	9400	-	1700	
	Large	15	8	5	13	10600	200	3300	

TABLE A4.3:

WASTE SOLVENT RESIDUALS BY GEOGRAPHIC
DISTRIBUTION - REGION 3

Size	Process	No. of Plants	No. of Plants Using			Sludges (kg/yr)	Solvent Losses		Cartridges (kg/yr)
			Stills	Diatomaceous Earth Filters	Cartridges		Filter Muck (kg/yr)		
<u>Perchloroethylene</u>									
Small	Transfer	365	256	33	333	15600	2000	19600	
	Hot	225	186	12	194	18800	500	8000	
	Refrigerated	18	14	-	18	1300	-	2500	
	Subtotal	608	456	45	545	35700	2500	30100	
Medium	Transfer	75	73	2	73	39300	100	28500	
	Hot	37	37	4	31	13500	2400	1800	
	Refrigerated	23	19	5	17	2800	600	900	
	Subtotal	135	129	11	121	55600	3100	31200	
Large	Transfer	8	7	3	5	3400	1700	1600	
	Hot	8	8	1	7	16000	700	1500	
	Refrigerated	1	1	-	1	800	-	300	
	Subtotal	17	16	4	13	20200	2400	3400	
Total			601	60	679	111500	8000	64700	
<u>Petroleum Solvent</u>									
Small	Transfer	68	34	20	54	6000	900	4900	
	Transfer	15	4	4	15	800	100	5300	
	Transfer	2	1	1	2	9500	14700	3400	
	Total	85	39	25	71	16400	15700	13600	

TABLE A4.4: WASTE SOLVENT RESIDUALS BY GEOGRAPHIC DISTRIBUTION - REGION 4

Size	Process	No. of Plants	Stills	No. of Plants Using		Sludges (kg/yr)	Solvent Losses		Cartridges (kg/yr)
				Diatomaceous Earth Filters	Cartridges		Filter Muck (kg/yr)		
<u>Perchloroethylene</u>									
Small	Transfer	44	31	4	40	1900	250		2400
	Hot	27	22	1	24	2200	50		1000
	Refrigerated	3	2	-	3	300	-		400
	Subtotal	74	55	5	67	4400	300		3800
Medium	Transfer	6	6	-	6	3200	-		2300
	Hot	3	3	-	2	1100	-		100
	Refrigerated	2	2	-	1	400	-		100
	Subtotal	11	11	-	9	4700	-		2500
Large	Transfer	3	3	1	2	1400	600		600
	Hot	4	4	1	4	8000	600		900
	Refrigerated	0	0	-	-	-	-		-
	Subtotal	7	7	2	6	9400	1200		1500
<hr/>									
	Total	92	73	7	82	18500	1500		7800
<u>Petroleum Solvent</u>									
Small	Transfer	8	4	2	6	900	100		600
	Medium	2	1	-	2	100	-		700
	Large	0	0	-	-	-	-		-
	Total	10	5	2	8	1000	100		1300

TABLE A4.5:

WASTE SOLVENT RESIDUALS BY GEOGRAPHIC
DISTRIBUTION - REGION 5

Size	Process	No. of Plants	No. of Plants Using		Stills	Sludges (kg/yr)	Solvent Losses		Cartridges (kg/yr)
			Diatomaceous Earth Filters	Cartridges			Filter Muck (kg/yr)		
<u>Perchloroethylene</u>									
Small	Transfer	17	1	15	12	700	60	900	
	Hot	11	1	9	9	900	40	400	
	Refrigerated	1	-	1	1	100	-	100	
	Subtotal	29	2	25	22	1700	100	1400	
Medium	Transfer	3	-	3	3	1600	-	1100	
	Hot	2	-	2	2	700	-	100	
	Refrigerated	1	-	1	1	200	-	100	
	Subtotal	6	-	6	6	2500	-	1300	
Large	Transfer	0	-	-	0	-	-	-	
	Hot	0	-	-	0	-	-	-	
	Refrigerated	0	-	-	0	-	-	-	
	Subtotal	0	-	-	0	-	-	-	
Total		35	2	31	28	4200	100	2700	
<u>Petroleum Solvent</u>									
Small	Transfer	3	1	2	2	400	100	100	
	Hot	1	-	1	0	-	-	400	
	Refrigerated	0	-	-	0	-	-	-	
	Subtotal	4	1	3	2	400	100	500	

TABLE A4.6:
WASTE SOLVENT RESIDUALS BY GEOGRAPHIC
DISTRIBUTION - REGION 6

Size	Process	No. of Plants	Still's	No. of Plants Using		Cartridges	Sludges (kg/yr)	Solvent Losses		Cartridges (kg/yr)
				Diatomaceous Earth Filters				Filter Muck (kg/yr)		
<u>Perchloroethylene</u>										
Small	Transfer	8	6	1		7	300	60		400
	Hot	5	4	-		4	300	-		200
	Refrigerated	0	0	-		-	-	-		-
	Subtotal	13	10	1		11	600	60		600
Medium	Transfer	2	2	-		2	1000	-		700
	Hot	1	1	-		1	400	-		100
	Refrigerated	0	0	-		-	-	-		-
	Subtotal	3	3	-		3	1400	-		800
Large	Transfer	-	-	-		-	-	-		-
	Hot	-	-	-		-	-	-		-
	Refrigerated	-	-	-		-	-	-		-
	Subtotal	0	-	-		-	-	-		-
<hr/>										
	Total	16	13	1		14	2000	100		1400
<u>Petroleum Solvent</u>										
Small	Transfer	2	1	1		2	200	100		200
	Hot	-	-	-		-	-	-		-
	Refrigerated	-	-	-		-	-	-		-
Medium	Transfer	-	-	-		-	-	-		-
	Hot	-	-	-		-	-	-		-
Large	Transfer	-	-	-		-	-	-		-
	Hot	-	-	-		-	-	-		-
	Subtotal	2	1	1		2	200	100		200

APPENDIX 5

ESTIMATED WASTE QUANTITY DISTRIBUTION BY DISPOSAL PRACTICE

TABLE A5.1
ESTIMATED QUANTITY OF SOLVENT LOSSES IN STILL BOTTOM SLUDGES BY DISPOSAL PRACTICE

Size	Process	Disposal Practice	SURVEY RESULTS				PROVINCE WIDE			
			No. of Plants	%	Quantity of Sludge (kg/yr)	Quantity of Solvent in Sludge (kg/plant/yr)	Total No. of Plants	No. of Plants Using Particular Disposal Practice	Quantity of Solvent in Sludge (kg/yr)	
<u>Petroleum Solvent</u>										
Small	Transfer	recycle	11	65	2200	625	57	570	370	21100
		garbage	1	5	300	90			29	2800
	Hot	recycle	13	71	4500	1285	100	352	260	25000
		garbage	2	11	800	225	110		19	3000
Medium	Refrigerated	recycle	3	75	1000	285	95	28	21	2000
		garbage								
	Transfer	recycle	31	91	61800	17600	570	110	101	57200
		garbage	1	3	300	85			3	300
Large	Hot	stockpiling	1	6	600	170			3	500
		recycle	6	86	8700	2400	40	56	48	19800
	Refrigerated	garbage	1	19	300	85			8	700
		recycle	10	82	5200	1680	150	33	27	4000
Petroleum Solvent	Transfer	recycle	19	93	23600	6725	480	17	16	7700
		garbage	19	100	98200	27985	2000	18	18	36000
	Hot	recycle	1	100	3100	885		1	1	900
		garbage								
Totals							1185	936	181900	
<u>Petroleum Solvent</u>										
Small	Transfer	industrial landfill	1	10	1300	490	390	105	11	4300
		garbage	2	20	1000	300	150		21	3100
Medium	Transfer	stockpiling	2	20	600	180	90		21	1900
		garbage	2	25	900	120	60	22	6	400
Large	Transfer	industrial landfill	2	67	66300	19890	9945	4	3	29800
Totals							131	62	39500	

TABLE A3.2: ESTIMATED QUANTITY OF SOLVENT LOSSES IN FILTER MUCK BY DISPOSAL PRACTICE

Size	Process	Disposal Practice	No. of Plants	SURVEY RESULTS			PROVINCE WIDE		
				%	Quantity of Muck (kg/yr)	Quantity of Solvent in Muck (kg/plant/yr)	Total No. of Plants	No. of Plants Using Particular Disposal Practice	Quantity of Solvent in Muck (kg/yr)
Perchloroethylene									
Small	Transfer Hot Refrigerated	garbage	3	9	700	170	570	51	2800
		garbage	1	5	200	50	352	18	900
Medium	Transfer Hot Refrigerated	garbage	1	3	100	25	110	3	100
		garbage	2	11	3000	1220	36	6	3700
Large	Transfer Hot Refrigerated	garbage	2	18	1000	295	33	6	700
		industrial landfill	5	33	11800	2880	17	6	3500
		industrial landfill	2	13	5300	1295	18	2	1300
		industrial landfill	-	-	-	-	1	-	-
						Totals	1185	92	13000
Petroleum Solvent									
Small	Transfer	garbage	3	30	900	195	105	32	1600
		garbage	1	25	100	15	22	6	100
Large		industrial landfill	1	33	90700	19700	9	1	19700
						Totals	131	39	16600

TABLE A3.3i

ESTIMATED QUANTITY OF SOLVENT LOSSES IN FILTER CARTRIDGES BY DISPOSAL PRACTICE

Size	Process	Disposal Practice	No. of Plants	%	SURVEY RESULTS										PROVINCE-WIDE		
					Solvent Content in Cartridge (kg/plant/yr)										No. of Plants	Using Method	Total Solvent Losses (kg/yr)
					SCC	SAC	SPP	JCC	JAC	JPP	JAD	Total					
Perchloroethylene																	
Small	Transfer	garbage	27	88	14	3	0.1	9	11	-	22	59.1	570	502		29,700	
		industrial landfill	1	3	36	16	-	-	-	-	-	52	1	17		900	
	Hot	garbage	15	76	13	9	0.2	5	3	0.2	19	49	352	268		11,900	
		industrial landfill	2	10	16	-	-	-	-	-	-	16	11	36		300	
Refrigerated	garbage	2	100	41	16	-	89	-	-	-	141	28	28		1,900		
Medium	Transfer	garbage	32	97	6	49	0.2	316	25	0.2	-	191.9	110	107		41,800	
		Hot	15	83	19	4	5	9	-	26	58	36	97		2,700		
	Refrigerated	garbage	7	64	19	7	0.3	-	-	-	39	60.3	33	21		1,100	
		industrial landfill	1	9	29	19	-	-	-	-	-	48.0	3	3		100	
Large	Transfer	garbage	10	67	91	12	-	31	43	-	146	3.3	17	11		3,600	
		Hot	15	83	69	21	56	-	57	-	133	18	15		2,700		
	Refrigerated	industrial landfill	1	6	-	-	-	668	-	-	-	13.8	1	1		700	
		garbage	1	100	-	52	-	157	-	-	-	209	1	1		200	
													Total			100,000	
Petroleum Solvent																	
Small	Transfer	garbage	8	80	26	7	-	2	15	-	41	91	105	89		7,600	
Medium		garbage	3	75	51	15	-	167	-	-	163	396	22	16		6,300	
		industrial landfill	1	25	-	-	-	-	-	-	237	237	6	6		1,600	
Large		garbage	2	67	-	-	-	809	75	289	69	1,232	4	3		3,200	
		industrial landfill	1	33	-	2100	900	-	-	-	-	3000	1	1		3,000	
													Total			22,200	

